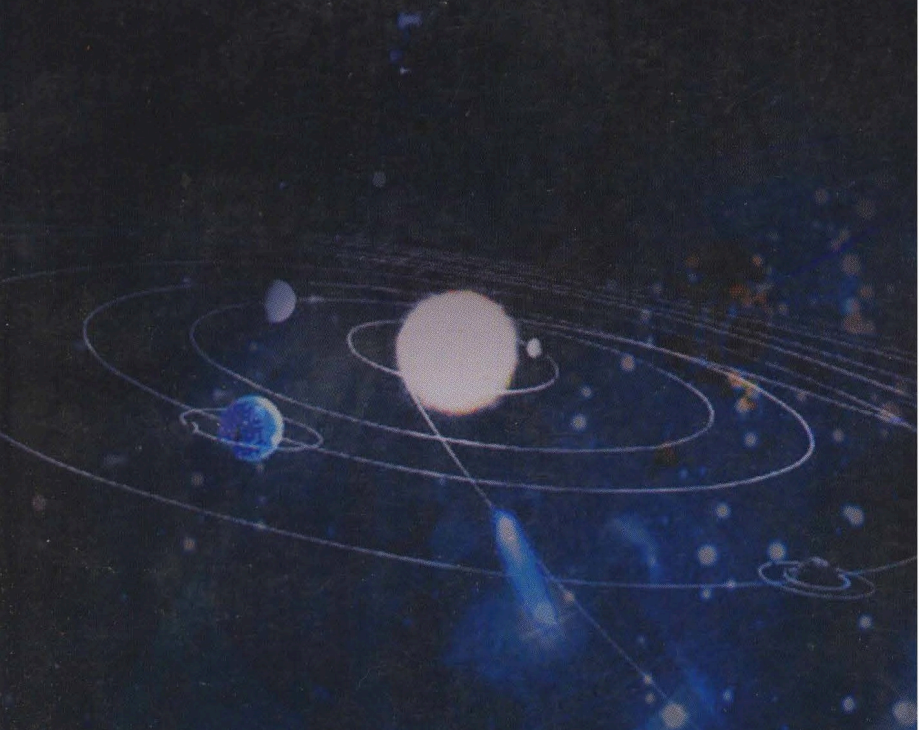
INDIAN TIME RECKONING

IN BROADER PERSPECTIVE

(Vistrit Parivaiksh Mein Bhartiya Kal Ganana)



Vijay Mohan Kumar Puri

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CONTENTS

1.

INTRODUCTION

Indian Time Reckoning or Bhartiya Kal Ganana is a subject that has a very limited awakening. Most of the literature on the subject exists in Sanskrit language. Translations in various other languages do exist and sizeable commentaries are also available. Even then, the subject matter has got confined to knowledge of a few terms that have been imbibed in the society due to mere *sanskara*. The present generation has gone beyond the limits of even its peripheral knowledge. The net casualty is the heritage which has been passed down to our generation and the realms of the subject got confined to scholars only. If the present trends continue, the day is not far when not many literate persons may be aware of knowledge that our Rishi relentlessly acquired through meticulous research and the entire innuendoes of the subject may pass into oblivion.

In order to illustrate the above scenario an interesting example can be cited. Most of the persons have heard words like Kal, Kaliyug, Satiyug, Kalp etc. but their meanings are not known to many. Therefore, a need was felt to deal with this subject in such a manner that could be understood by any literate person possessing only a peripheral interest in the subject. Consequently, special care has been taken to use a language that is very simple and uses common day to day words so that such a complex and intricate subject could be understood by almost every body. Efforts have also been made to tackle problems by using minimum scientific terminology. Wherever

it has become inevitable to use those terms, explanatory notes have also been exhaustively incorporated.

Indian Time Reckoning or Bhartiya Kal Ganana involves a subtle subject that hinges around Kal and its ganana or reckoning. Therefore, it is essential first to clearly understand what Kal means. The term Kal is derived from a Sanskrit word "*Kel sankhyane*" which means the one who counts. Therefore, Kal counts life of all moveable and immoveable bodies and absorbs them in the end. It is an omnipresent and invisible element that possesses a *gati* or motion that connects past, present and future. Therefore, one can not discern it completely in all respect though one can experience a portion of it through ganana or reckoning. It has no beginning and its end is also not known. It is an eternal phenomenon that causes certain events those are noticeable in the absolute form but Kal itself is infinite and can not be perceived.

Rig Ved explains element of Kal that it is *nirapeksha* or impartial as well as *sapaiksha* or relative. Even though it is rootless but it is the root of the Cosmos.

Trinabhi chakramjaramanavam yatrema vishwa bhuvanadi tasthuh[1]

Here, Rig Ved takes cognizance of Kal element and attributes it to *samvatsar pradhan* or synchronized chronology. On the other hand, Mandook Upanishad suggests that Kal is endowed with property of birth like all other elements.

Tasmadrichah sama yanjooshi deeksha yagyashcha sarvay kratvo dakshinashcha
Samvatasarashcha yajmanascha lokah somo yatra pavate yatra suryah[2]

Here, again term samvatsar has been explained as Kal by Acharya Shri Shankar as *Samvatsarashcha Kalha karmangama.* Manu Smriti also mentions about Kal.

Kalm Kalvibhaktishcha nakshatrani grahamstatha[3]

In above shlok or verse, Kal has been attributed to motion created by Surya or the Sun and *Kalvibhakti* refers various elements of time like *kshan* or second, day, month, year and Kalp etc.

Jha (1985)[4] has quoted Bhojraj in Kalmadhav in which it is explained that Kal originates from the basic tenet of *prakriti* or nature. The relavant shlok or verse from Kalmadhav is re-produced below:-

Punso jagataha kritya mayatatatva panchakam bhavati
Kalo niyatishacha tatha kula cha vidya cha ragashcha
Nanavidhashaktimayee sa janayati Kaltatva mayvadao
Bhavibhavadbhootamayam Kalyati jagdesha kaloatah

Five elements including Kal are generated from *maya* or cosmic illusion and its male component is called *purush* for the creation of the Srishti or Cosmos. In other words, many types of powerful eternal nature create elements of Kal. This Kal is an embodiment of future, present and past. This Kal is responsible for reckoning of every worldly creation. Hence, it is known as Kal.

In above shlok or verse, first future, followed by present and later past has been elucidated. Accordingly, Kal has been illustrated to its root doctrine. The aspect of the future depending upon the present and latter on the past has been advocated. Bhojaraj emphasized the computational aspect of Kal that is mentioned in "*Kalyati jagadesha kaloatah*" component of above shlok. Therefore, this aspect of Kal has been acknowledged as womb of *prakriti* or nature that accounts

for *graham* and *nakshatra* or planets and constellation etc. However, it does not refer to its spiritual connation of *nitya* Kal or eternal one which is the embodiment of Supreme Power and is beyond the scope of this publication.

Lokanamantkrit Kalha kaloanyah kalnattamakah
Sa dvidha sthoolasookshamatvan moortashchamoorta ucchcchyate
Pranadi kathito moortastutyadyoamoortasangyakaha[5]

Rishi of Surya Siddhant has further clarified this aspect of Kal. Terminator of all *char* and *achar* or moveable and immoveable *lok* or worlds is primarily Kal that is not computable. It is different from the computable Kal that is unreal. This unreal or practical Kal possesses two segments namely *sthool* or gross and *sooksham* or subtle; former is also known as *moorta* whereas *sooksham* or subtle is known as *amoorta*. The time taken for breathing and high level of Kal is known as *moorta* while lesser or micro level is called *amoorta*.

Sa Kalh parmanurvaiee yo bhungakte parmanutam
Satoavishaishabhugyastu sa Kalha parmo mahan[6]

According to the above shlok from, Bhagvat Puran, Kal exists in *sooksham* or infinite state of *parmanu* or an atom. The one that enjoys all the stages from extreme *sooksham* to the beginning of Srishti or the Cosmos is the great Kal. It is the embodiment of all *grah* (planets) or *nakshatra* (constellations), stars, and galaxies which are the manifestation of Kal.

In another shlok from the same chapter in Bhagvat, precise value of Kal has been quantified.

Garharakshatarachakrasthah parmanvadina jagat
Samvatsaravsanaina paretyanimisho vibhuh[7]

This shlok is the most significant attempt by Rishi to quantify Kal. Acharya Shridhar has explained this verse in his commentary that the lowest Maan or value of Kal is the time taken by Surya or the Sun to transgress parmanu or atom. The speed of the light of the Sun is 2, 99,792 Km/s or 2 lakh, 99 thousand, 7 hundred and 92 kilometers per second. The diameter of hydrogen parmanu or atom is 1.05832×10^{-8} cm. Therefore, light of the Sun will transgress hydrogen atom in 3.53018×10^{-19} second. To clarify further, it works out to be minutest of the minutest mathematical value that has been attributed to Kal.

The subject matter in this book has been innovatively arranged in such a manner that clarity is maintained in all levels of analysis. Most of the data sets have been catalogued into various Tables for simple clarifications and ready reference. A resume' of this arrangement is given hereunder.

In second chapter, a brief input is provided on various leading instruments of time cataloguing in vogue. Important and popular samvatsar or calendars are outlined in brief wherein only salient features are enumerated. An attempt has also been made to highlight the scientific component needed to design these various samvatsar or calendars.

Third chapter deals with basic knowledge on various nakshatra or constellations and rashi or signs. Bhartiya Rishi or Indian scientists designed various terms that have been explained in consonance with modern terminology. A care has been taken to organize voluminous data in proper format for simple analysis.

General and modern scientific information of our Saur Mandal or Solar System is incorporated in fourth chapter. It is positively a vital input wherein various properties of star, planets and satellite are very briefly included. The purpose of this data is to appraise the reader with minimal but workable

scientific astronomical information in order to understand the inter play of different elements.

Bhartiya Kal Ganana or Indian Time Reckoning has been dealt with in next two chapters namely fifth and sixth ones. An arbitrary classification of Kal Ganana or Indian Time Reckoning has been designed for this book only for simple explanation of subtle principles with suitable references. In fifth chapter micro and macro levels of Kal Ganana has been discussed. First component is micro Kal Ganana that deals with such portion of Kal Maan or Time Measure that is less than an ahoratra or 24 hours or a day. Higher time units were also designed after conducting a thorough research by Rishi to account for perceptible time units experienced by mankind. Therefore, study of micro level time units is succeeded by Kal units at a macro level. These time units encompass calculations to delineate the limits of a day, week, month, *ritu* (seasons), and a year.

The sixth chapter discusses mega level of Kal Ganana. The appellation – mega level of Kal Ganana or Time Reckoning in the present expression that is absolutely restricted to this book only, denotes any portion of Kal Maan or Time Measure which is higher than one year. Therefore, this chapter of mega level of Kal Ganana deals with Kal Maan or Time Measure from the lapse of one year till ancient times of creation of Srishti or beginning of the existence of the Cosmos.

Seventh chapter experiments with a rudimentary idea of correlation between Shvet Varah Kalp or the first day in life of Brahma's 51st year and present day knowledge of geology. It is an effort that has not been ever implemented on a scientific plane. Hence, a preliminary conceptual model has been developed in which knowledge derived from two distinct but independent sources evolved in different time and space employing absolutely diverse philosophies and methodologies.

2.

SAMVATSAR OR CALENDARS IN VOGUE

In every civilization viz. Bhartiya or Indian, Chinese, Egyptian etc. scholars have attempted to take stock of time management so that it could be catalogued in a scientific and logical manner. They have also attempted to account for the origin of the Cosmos as well as Prithivi or the Earth in their own way. Therefore, this process involves extensive use and cataloguing of digits, events, activities or sometimes personalities. Therefore, records were kept in which mostly two parameters were employed. Major events and renowned personalities like kings and emperors or religious personalities or prophets of various societies or civilization constituted the basis of this effort. Consequently, a register of days, months and years evolved on scientific and logical basis, is kept in a systematic manner which is known as Samvat or calendar. A samvat keeps a chronological record of various events, festivals, rituals/ceremonies etc. of the race or civilization or countries. Though every country or civilization claims that the calendar adopted by them is the most valuable in content but detail analysis is needed for this purpose.

Some of important Samvat or calendars are discussed in the following pages in order to evaluate its validity in terms of its scientific content and structure.

Gregorian Samvat or Calendar

This samvat or calendar is the most common one that has been accepted the world over and is being utilized by almost every country. It is a product of Christian faith. Archbishop Uber had declared that the Earth was created at 9 A.M. on 26th February, 4004 B.C (Before Christ). God created the Sun, stars and land in five days and Adam on sixth day. Asimov (1967)[8] stated "Indeed, as the nineteenth century opened, most European scientists were still under the spell of the literal language of the Bible and assumed that the Earth had existed for only 6000 years or so. Eighteen million years would have seemed a blasphemously large figure to most of them."

The precursor of this cataloguing is a Roman Samvat or calendar that was started in 753 B.C. with establishment of Rome. Initially, there were 304 days in a year spread over 10 months from March to December. Romans adopted this calendar but soon problems commenced as error started creeping in the calendar with passage of time. In order to rectify those errors, Emperor Julius Caesar during 46 B.C. created 455 days in a year that was later modified into 365 days. Simultaneously, Emperor Caesar added another month in the calendar that bears his name or July that was inserted after the first six months. Now, a year consisted of eleven months and the New Year was continued to be celebrated on 25th March.

Subsequently, his great grandson, Emperor Augustus followed the foot steps of his great grandfather and got yet another month inserted in the calendar in 8 B.C. Therefore, an additional month of August was added after July in it, thus, increasing the number of months to twelve. Emperor Augustus further standardized number of days in a month and nomenclature was provided to every month in a sequential

manner. Consequently, Roman calendar acquired twelve months and 365.25 days in a year.

Even after affecting those modifications, error continued to creep in this system of reckoning. The problem arose because Roman year of 365.25 days was longer than the true year comprising 365.2422 days by 0.0078 days. This discrepancy could only be noticed after the passage of almost one thousand and five hundred years. It was found to the great annoyance of Roman Catholic Church that observance of Easter had shifted by a few days. Therefore, error in the calendar had accumulated to 10 days in 1582 A.D (Anno Domini or in the year of Our Lord). In order to affect rectification in the system of calendar calculations, the then Pope Gregory XIII issued papal decree in that year. He ordained that Friday, 5th October, 1582 A.D. would hence forth be counted as Friday 15th October, 1582 A.D. The Holy Pope further ordained that future centurial years not divisible by 400, were not to be counted as a leap year. Nonetheless, the New Year was continued to be celebrated on 25th March of every year.

It, therefore, implied that any year divisible by 4 would continue to be treated as a leap year wherein one day is increased in the month of February. As a consequence to this endeavour by Roman Catholic Church, century years like 1700, 1800 and 1900 etc. though divisible by four were not treated as leap years. Thus, the numbers of leap years during a period of 400 years were reduced from 100 to 97 and span of a year in the calendar got reduced to 365.2425 days.

This samvat or calendar was officially introduced in 1752 A.D. in Great Britain. The English also faced above mentioned problems since an error of 11 days had crept in the calendar. They addressed this problem in still an arbitrary manner as was done by Pope Gregory almost 170 years ago. During that year, Thursday, 3rd September was designated as Thursday, 14th September and the calendar was officially assigned the name of

Gregorian calendar. Concomitantly, celebrations of a new year were shifted from 25th March to 1st January in Great Britain. This calendar, now known as Gregorian Calendar, was gradually adopted by most of the European countries and under the impact of British influence in the world during 18th and 19th centuries, this calendar was accepted by most of the countries.

Variable parameters were taken into account for imparting names to various months of this calendar that are listed below:-

Roman gods, festivals and seasons for the first six months of the Calendar
Names of Emperors like July or August
Residual Roman months like September or Septem (seven), October or Octo (eight) etc.

It will further interest to get a brief input on the nomenclature of various months of Gregorian calendar.

January is named after the Roman god, Janus. He is considered to be god of doorways, entrances, gateways, thresholds and beginnings. He possesses two faces that look in opposite direction. This month was allotted 31 days and was placed as 11th month as per earlier belief but later it was assigned the status of first month of the calendar.

February is named after the Roman festival of purification that was known as Februa. February month dates back to the times of founding of Rome and it had 23 days during those days. It was the last month of the calendar till 1752 A.D. when it was assigned the status of second month of the calendar.

March gets its name from the Roman god Mars who was the god of war and guardian of the state. Mars was considered to be father of Romulus and Remus. It was the first month of Roman calendar but was shifted to 3rd position later on. It has 31 days assigned to it.

April acquires its original name Aprilis in Roman calendar that was changed to April at a later date. April is derived from Latin word aperire meaning "to open". It referred to spring season, opening of the flowers and leaves. It was a second month of the Roman calendar but later changed to fourth one having 30 days.

May is named after Roman goddess Maia who was the daughter of Atlas and one of the Pleiades. Romans utilized it as third month but later it was altered to fifth month in which 31 days were assigned.

June is named after goddess Juno who was wife of Jupiter and queen of the heavens and gods. It was the fourth Roman month that was later changed to sixth position. This month was allotted 30 days.

July, Emperor Julius Caesar got this month inserted in the calendar in 44 B.C. that was the 11th month of the calendar. His royal wish enabled to be allotted 5th position that was later altered into 7th one. It was given a quota of 31 days.

August, Great grandson of Emperor Julius Caesar, Emperor Augustus followed the foot steps of his great grandfather and got this month inserted as 12th month in the calendar in 8 B.C. Emperor Augustus ensured that 31 days were allotted to it and this month was placed at 6th position that was later changed to 8th one.

September was 7th month of the year in Roman calendar and Romans called it Quintilis till Emperor Caesar and later his great grandson Emperor Augustus had their royal interventions. Its name is derived from the Latin word septem that means seven and has been given the portfolio of 30 days. It was later assigned to 9th month of the calendar.

October was 8th month of Roman calendar and derives its name from the Latin word Octo meaning eight. It was later shifted to 10^{th} month of the calendar and allotted 31 days.

November was 9^{th} month of Romans that owes its origin to the Latin word nove meaning nine. It was shifted to 11^{th} position in the calendar that has 30 days.

December was the last and 10^{th} month of Roman calendar that was named after the Latin word decem meaning ten. It was shifted to 12^{th} position in the calendar at a later date and was assigned 31 days.

A resume of this calendar clearly brings out a point that in pursuit of its formulation, none of the scientific parameters have been taken into consideration and all changes have been affected in an arbitrary manner.

Chinese Calendar

The Chinese have computed that 96 million or 9 crore and 60 lakh years have elapsed from the time of their First Emperor to the time of the Chinese philosopher Confucius. It was 500 B.C. when Confucius established his school in philosophy. Therefore, 9, 60, 02,506 years have passed from the days of first Chinese Emperor till 2006 A.D.

The ancient Chinese Samvat or Calendar is a lunar one that came into existence during 2637 B.C. It is divided into 12 months and each month consists of 29 or 30 days depending upon duration of the lunar month. Chinese have further synchronized the calendar with solar year by incorporating extra months at fixed intervals like Indian luni – solar calendars. Each Chinese year is correlated with 12 animal designations. It is interesting to record that animal term for the year 2006 A.D. is Dog.

This calendar is based on Sexagenary or 60 years cycle. The Chinese New Year begins on first Amavasya or new moon day after the Sun enters tropical Kumbh rashi or Aquarius sign. This day may fall between 21st January and 19th February. The date of New Year is fixed according to the occurrence of new moon in the Far East. In 1983 A.D., 77th Sexagenary cycle of the Chinese calendar was completed. Now, 23rd year of 78th Sexagenary cycle is in progress in 2006 A.D.

Chinese months are designated on numerals like 1, 2, 3 etc. and no specific name has been assigned to it. A day begins at midnight and ahoratra or 24 hours day is divided into 12 parts. One sub - cycle of 12 years along with their animal designations is described hereunder:-

1.	2005 A.D.	Rooster	2.	2006 A.D.	Dog	3.	2007 A.D.	Pig
4.	2008 A.D.	Rat	5.	2009 A.D.	Ox	6.	2010 A.D.	Tiger
7.	2011 A.D.	Hare	8.	2012 A.D.	Dragon	9.	2013 A.D.	Snake
10.	2014 A.D.	Horse	11.	2015 A.D.	Sheep	12.	2015 A.D.	Monkey

This sub - cycle of 12 years is repeated up to 60 years. Thus, there are five such sub–cycles of 12 year duration in the Sexagenary calendar.

Hejira or Islamic Samvat or Calendar

Hejira samvat or calendar is prevalent amongst Muslims and is utilized extensively in pursuit of religious ceremonies. Prophet Mohammed, the founder of Islam, had shifted from Mecca to Medina due to persistent harassment by his enemies on 15th July, 622 A.D. After 17 years, Caliph Omar decided to start Hejira Samvat or calendar from the day the Prophet left Mecca

for Medina from 1st Moharrum day. It is a lunar month that begins on 1st or 2nd lunar day of Shukla Paksha or bright fortnight subject the visibility of the moon. Its date begins in the evening. If a month starts on 1st day subject to visibility of the moon, it has 30 days otherwise the month comprises 29 days. Since the calendar is a lunar one, one month is added after a lapse of 32.5 years. Consequently, its months shift backwards. Table 1 gives pertinent data concerning this calendar.

Table 1: Hejira Samvat or Calendar

Sr.No.	Month Name	Days	Sr.No.	Month Name	Days
1	Moharrum	30	7	Rajab	30
2	Safar	29	8	Shaban	29
3	Rabi-ul-awwal	30	9	Ramadan	30
4	Rabius' sani	29	10	Shawwal	29
5	Jammad-ul-awwal	30	11	Z'ulquada	30
6	Jamadus' sani	29	12	Zulhijja	29

Further, Zulhijja or last month will consist of 30 days provided Hejira calendar is divided by 30 and remainder happens to be 2, 5, 7, 10, 13, 16, 18, 21, 24, 26 or 29.

Bhartiya Samvat or Indian Calendar

It is needless to emphasize that older civilizations will follow equally ancient samvat or calendars. Therefore, Bhartiya Samvat or Indian Calendar is the oldest calendar that has been followed in pursuit of social, cultural and religious activities. It

is interesting to record at this stage that Bhartiya Samvat or Indian Calendar has not been related to any man made activity, thought, personality like kings, Emperors etc. but it is based on complex and intricate astronomical phenomena. As the time passed in older Indian civilization, many significant events occurred and many personalities proliferated. As a consequence of these developments, many samvat or calendars came into existence in India.

Kalp Samvat or Kalp Calendar

The oldest Bhartiya samvat or Indian Calendar is known as Kalp Samvat or Calendar. It is based on Kal Ganana or Time Reckoning that is dependant on nakshatra or constellation and intricate astronomical phenomenon. This calendar pertains to two aspects that are called Srishtiabd or calendar of creation of the Cosmos or Kalpabd or calendar of the beginning of Kalp. Hence, Indian Calendar does not belong to any race, culture, civilization etc. since it is the most ancient one that embraces the entire humanity.

Bhartiya Kal Ganana or Indian Time Reckoning deals with two distinct *paksha* or aspects. First aspect pertains to the creation of the Cosmos. Rishi or Indian hermits were great scientists and it was computed that first Parardha or span of 50 years of the life of Brahma (the Creator), has already elapsed. In terms of interpreting above expression (that will be explained later in this book), it was calculated that 50 years in the life of Brahma correspond to 155.52 trillion or 155.52e12 years. In other words, the Cosmos came into existence 155.52 trillion years ago and this Samvat or Calendar is known as Srishtiabd or Calendar of the Cosmos. The detailed calculations reveal that the Cosmos came into existence on Chaitra, Shukla Pratipada or 1st lunar day of bright fortnight of Chaitra or 1st lunar month, 15,55,21,97,29,49,108 years ago (till 2006 A.D.).

The second *paksha* or aspect of Bhartiya Kal Ganana or Indian Time Reckoning accounts for origin of the Earth and this

Samvat or Calendar is known as Kalpabd. This calendar was started on Magh Shukla Triteeya or 3rd lunar day of Shukla Paksh or bright fortnight of Magh Mas or 11th lunar month 1970 million or 1970 x10 6 years ago. Therefore, precise calculations reveal that the Earth came into existence 1,97,29,49,108 years ago in 2006 A.D.

Further, reckoning of Rishi or hermits reveals that Brahma took 17.064 million or 1, 70, 64,000 years to create life on the Earth. Therefore, it was 1,95,58,85,108 years ago (till 2006 A.D.) that life on our planet made its first appearance. Therefore, Kalpabd is the oldest Samvat or Calendar of the World.

Some of important calendars including Indian ones are given in Table 2.

Table 2: Important Samvat or Calendars

Sr. No.	Calendar Name	Present/ Past	Trop. / Sid.	Lunar/Solar	Beg. Year	Yr. Beg. Date	Area
1	Srishtiabd	Past	Sidereal	Luni-Solar	15,55,21,97,29,49,108		World
2	Kalpabd	Past	Sidereal	Luni-Solar	1,97,29,49,108		World
3	Chinese	Past	Tropical	Luni-Solar	9,60,02,304		China
4	Julian	Present	Tropical	Lunar	4713 BC	25th March	
5	Saptrishi/ Ursa Major	Present	Sidereal	Lunar	3076 BC	Chaitra, Shukla	India
6	Egyptian	Past	Tropical	Lunar	2,76,060		Egypt
7	Turkish	Past	-	-	7613		Turkey
8	Persian/ Iranian	Past	-	Solar	6011		Iran
9	Jews	-	Tropical	Luni-Solar	3661 BC	Sept.	Israel
10	Kaliyabd	Present	Sidereal	Luni-Solar	3102 BC	19 Feb.	India
11	Chinese	Present	Tropical	Luni-Solar	2637 BC	February	China
12	Vikram	Present	Sidereal	Luni-Solar	57BC	Chaitra, Shukla	Nor. India
13	Vikram	Present	Sidereal	Solar	57BC	April	Nor. India
14	Shak	Present	Sidereal	Solar	78AD	April	India
15	Hejira	Present	-	Luni-Solar	622 AD	Moharrum	Islam

3.

NAKSHATRA AND RASHI OR CONSTELLATION AND SIGN

Nakshatra or constellation and Rashi or sign are the most familiar words to every person from any walk of life. Usually these appellations are used in a very loose manner without understanding its implications. In view of this background, it is imperative to clearly understand this terminology before we proceed further. These terms acquire two fold connotations. The first one is a division of the zodiac into various segments that is based on some fixed logic. Zodiac is a broad belt of 16 degrees extending 8 degrees on either side of the ecliptic. For instance, there are 360 degrees in any circle or ellipsoid. Therefore, a 30 degree division of an ellipsoid will generate 12 such segments that are known as rashi or sign. Simultaneously, a 13 degree 20 minute division of an ellipsoid will create 27 such segments that are called nakshatra or constellation. The second connotation has an astronomical implication because nakshatra or constellations and rashi or signs are also heavenly bodies that are located around our Saur Mandal or solar system. These heavenly bodies possess distinct shape, orientation and fixed mathematical values. Therefore, both aspects of the definitions are utilized in this chapter so that a meaningful understanding of the subject is achieved.

At the outset, it is appropriate to mention that our Saur Mandal or Solar System is helio -- centric. In other words, Surya or the Sun is *sthir* or stationary and all the planets revolve around it along their respective paths. On the other hand, a geo – centric

model has also been developed by our Rishi. In this model, it is "assumed" that Prithivi or the Earth is *sthir* or stationary and all other planets revolve around it. It is further assumed that Surya or the Sun "revolve" around Prithivi or the Earth since the parameters pertaining to the Earth had also been "transferred" to the Sun. This model was developed by Rishi or Bhartiya *Vaigyanik* or scientists to facilitate observations when viewed or recorded from the Earth.

Nevertheless, it is well known even to a lay man that helio – centric model is prevalent in nature wherein Prithivi or the Earth revolves around Surya or the Sun along a path which is called ecliptic, year after year and centuries after centuries. However, only the few know that the Earth revolves around the Sun at the rate of 0.1 million km per hour and completes 966 million km long ecliptic path in approximately 365.25 days. It is interesting to record that this rate of revolution has not been static but contrary to the expectations, it has been registering an increase from the day the Earth came into existence. Consequently, its distance from the Sun has been increasing at the rate of 1.5 cm per year or 159 m in 10,000 years. Therefore, its ecliptic path that is occasionally known as orbit also has concomitantly been increasing at the rate of approximately one km in 10,000 years. In other words, the revolution of the Earth increases by an hour in 16 million or one crore sixty lakh years.

These computations lead us to very interesting results that 1970 millions or 197 crore years ago, our Prithivi or the Earth used to revolve around Surya or the Sun in 360 days. Our Rishi had also recorded this information and were aware of the aforesaid phenomenon. Based on this background, our Rishi divided a circle or ellipsoid in 360 ansh or degrees. Each ansh or degree was further subdivided into 60 kala or minutes whereas each kala or minute got further divided into 60 vikala or seconds.

It is added that the ecliptic of the Earth is not circular in shape but its shape is ellipsoidal or egg- shaped. A broad belt of 16 degrees

extending 8 degrees on either side of the ecliptic is called zodiac. All the planets in our solar system are located within this zodiac. Prithivi or the Earth follows its ecliptic while orbiting around the Sun whereas other planets of our solar system do not strictly follow their respective paths while revolving around the Sun. In other words, it can be deduced that the paths of other planets revolving around the Sun, are sometimes along the ecliptic, but these planets do occasionally revolve north of the ecliptic and on other times, revolve south of it. However, it is striking to record that these planets do not swerve towards north or south of the ecliptic beyond 8 degrees. A planet in northern portion from the ecliptic line is called to be parked in northern latitude whereas when it is in its southern portion from ecliptic, it is known to be posited in southern latitude.

Moreover, the north-south or polar axis of the Earth is tilted 23.5 degrees from the normal on the equator. The Earth rotates or spins around its axis from west to east at the rate of 1600 km per hour and completes one rotation in approximately 24 hours or 60 *Ghati* which is called ahoratra or a day.

Nakshatra or Constellations

Rishi or hermits had monitored the existence of two types of heavenly bodies in and around our Saur Mandal or Solar System and other visible heavenly bodies of our Parmeshthi Mandal or Milky Way or our galaxy. Those heavenly bodies that emit light are termed as *Deyu* or luminary whereas the others who do not possess any light and are known as *Prithivi* or inert. Nakshatra or constellations fall in the first category since these are group of luminary stars that are situated within the circumference of the ecliptics of the Earth and the Moon. These are discernible from the transit of the Moon as it traverses these groups of stars daily during the course of its revolution along its path around the Earth and returns to its original position on 28th day. This reason accounts for the adage that the Moon is ruler of nakshatra or constellations.

Divi somo adhishritah[9]

Rig Ved states that the Moon is located in luminary world. It implies that all such luminaries or fixed stars are traversed by the Moon during the course of its one revolution around the Earth. Therefore, during the course of observations/research by our Rishi, 218 highly illuminating stars were identified around the ecliptic of the Moon. Hence, on the basis of this daily lunar phenomenon, i.e. passage of the Moon in front of these illuminating fixed stars, 27 prominent groups of fixed stars were delineated that were known as nakshatra or constellations. Moreover, the most illuminating star amongst these groups of stars comprising a nakshatra or constellation is called Yogtara.

In other words, it is interesting to record that the polar axis of the Earth is tilted 23 degrees and 30 minutes on its equator while that of the Moon is 5^{0} on its equator. Hence, its ecliptic path is restricted to 28.5 degrees (23.5 + 5 degrees). Amongst millions of illuminating stars, only those lying within a span of aforesaid latitudes have been taken into cognizance. Therefore, all nakshatra or constellations are located within 28.50 latitude from the Earth because only those constellations were selected that lie between the paths of the Earth and Moon.

The primary data on nakshatra or constellations is listed hereunder in Table 3 that is based on concept provided by Lahiri (2006)[10]

The scrutiny of the aforesaid Table brings out very interesting information that generally and often escapes attention. Revati or ζ Piscium is the most illuminating nakshatra that possesses luminary value of 5.24 magnitude whereas Swati or α Bootis constellation acquires the least value of – 0.04 magnitude. There are six nakshatra or constellations whose illumination value lies between 3 and 4 magnitudes. On the other hand, there are four nakshatra or constellations possessing illumination value of less than 1 magnitude.

Table 3: Nakshatra Or Constellations

(On 1st January 2006 AD at 11h 21 m I.S.T.)

Sr. No.	Indian Name	Star	Bhogansh or Sidereal longitude	Sher or latitude	Star Nos	Magnitude	Shape
1	Ashwini	β Arietis	00 - 13.20	+8 .29. 15	3	2.64	Face of a horse
2	Bharani	41 Arietis	13.20 - 26.40	+10.27.00	3	3.63	Yoni (female genital)
3	Krittika	η Tauri	26.40 - 40.00	+4.03.05	6	2.87	Curved knife
4	Rohini	α Tauri	40.00 - 53.20	- 5.28.02	5	0.85	Cart
5	Mrigsheera	λ Orionis	53.20 - 66.40	- 13.22.09	3	3.66	Face of a deer
6	Ardra	α Orionis	66.40 - 80.00	- 16.01.36	1	Var.	Jewel
7	Punarvasu	β Germinorum	80.00 - 93.20	+ 6.41.04	4	1.14	House
8	Pushya	δ Cancri	93.20 - 106.40	+ 0.04.38	3	3.94	Arrow
9	Ashalesha	ε Hydrae	106.40 - 120.00	- 11.06.14	5	3.38	Circular
10	Magha	α Leonis	120.00 - 133.20	+ 0.27.54	5	1.39	House
11	Poorv phalguni	δ Leonis	133.20 - 146.40	+ 14.20.21	2	2.56	Manchaka (Dias resting on column)
12	Uttarphalguni	β Leonis	146.40 - 160.00	+12.15.59	2	2.14	Small cot
13	Hasta	δ Corvi	160.00 - 173.20	-12.11.48	5	2.95	Hand
14	Chitra	α Virginis	173.20 - 186.40	-2.03.18	1	0.98	Peart
15	Swati	α Bootis	186.40 - 200.00	+30.44.00	1	-0.04	Coral
16	Vishakha	α Libra	200.00 - 213.20	+0.19.57	4	2.75	Toran (an arched doorway)
17	Anuradha	δ Scorpii	213.20 - 226.40	-1 59.11	4	2.32	Vali (fold or wrinkle)
18	Jyeshtha	α Scorpii	226.40 - 240.00	-4.34.14	4	Var.	Like a circular ear ring
19	Moola	λ Scorpii	240.00 - 253.20	-13.47.20	3	1.63	Tail of a lion
20	Poorvashadh	δ Sagittarii	253.20 - 266.40	-6.28.22	11	2.7	Tusk of an elephant
21	Uttarshadh	σ Sagittarii	266.40 - 280.00	-3.26.59	2	2.02	Manchaka (Dias resting on column)

Sr. No.	Indian Name	Star	Bhogansh or Sidereal longitude	Sher or latitude	Star Nos	Magnitude	Shape
	Abhijit	α Lyrae		+61.43.58		0,03	
22	Shravan	α Aquilae	280.00 - 293.20	+29.18.12	3	0.77	Aeroplane
23	Dhanishtha	β Delphini	293.20 - 306.40	+31.55.04	4	3.63	Mridang percussion instrument
24	Shatbhisha	λ Aquarii	306.40 - 320.00	-0.23.12	100	3.74	Ecliptic
25	Poorvabhadrapad	α Pegasi	320.00 - 333.20	+19.24.22	2	2.49	Manchaka(a Dias resting on column)
26	Uttarbhadrapad	γ Pegasi	333.20 - 346.40	+12.36.00	2	2.83	Twins
27	Revati	ζ Piscium	346.40 - 360.00	-0.12.48	32	5.24	Mardala (kind of a drum)

Number of stars in each nakshatra or constellation varies from 100 to 1. For example, Shatbhisha or λ Aquarii constellation possesses 100 stars within its own ambit while Poorvabhadrapad nakshatra or α Pegasi constellation has 11 stars in its portfolio. On the other hand, Ardra or α Orionis, Chitra or α Virginis and Swati or α Bootis constellation contain only one star each. Almost 51.9% of nakshatra or constellations occupy northern Sher or latitudes while the remaining one is located in the southern Sher.

The above mentioned 27 nakshatra or constellations are located on the ecliptic of the Earth and the Moon encompassing 360 degrees or 21600 minutes. Consequently, the domain of each nakshatra or constellation is calculated to be 13° 20' or 800 minutes (360° divided by 27). Further, each nakshatra has been further divided into four Pad or Charan or Quarter. Each Charan or Pad has a domain of 3 degrees 20 minutes or 200 minutes of sidereal longitude. It is important to stress that all computations begin with Ashwini nakshatra or β Arietis constellation which happens to be the first nakshatra and end with last or twenty seventh nakshatra called Rèvati or ζ Piscium which covers the entire ecliptic.

Yogtara term is employed to describe the most illuminating star amongst the group of stars of a nakshatra or constellation. It is quite logical to appreciate and understand that Yogtara can never occupy the entire domain or 13 degrees 20 minutes of nakshatra or constellation. Moreover, it also imbibes the luminary rays of other co-axial stars by virtue of its accelerated dynamic position. Bhogansh is the term used to describe its nirayani or sidereal longitude whereas its latitude is called Sher as mentioned earlier. By now it is clear that Yogtara of a nakshatra is its very important parameter. In case, Yogtara is located north of ecliptic, it is known as northern Sher and similarly southern Sher is designated.

Moreover, on referring above Table 3, it is observed that Shatbhisha or λ Aquarii is the 24th nakshatra or constellation when counted from Ashwini nakshatra or β Arietis constellation. It contains 100 illuminating ecliptic shaped stars, which occupy a zone of 306 degrees 20 minutes to 320 degrees (Bhogansh or sidereal longitude) in the zodiac. The Yogtara or the most illuminating star of Shatbhisha nakshatra is λ Aquarii that possesses 3.74 magnitudes and its Bhogansh or sidereal longitude was 317 degrees 43 minutes and 09 seconds at 5.30 A.M. on 1st January 2006. Therefore, it is quite explicit from this example that its Yogtara also known as λ Aquarii; does not cover the entire domain of Shatbhisha nakshatra.

Nonetheless, whenever a planet gets aligned with Bhogansh of the Yogtara of a nakshatra during the course of its revolution; that planet is deemed to be posited in conjunction with that particular nakshatra. For example, whenever the Moon or any other planet like the Mars or the Venus etc., gets posited at 317 degrees 43 minutes and 09 seconds (317° 43' 09" ; being the Bhogansh of the Yogtara of Shatbhisha nakshatra) during the course of its revolution; it is said to be in conjunction with Shatbhisha nakshatra. Nonetheless, whenever the Moon or any other planet transits a zone of 306 degree 40 minutes to 320 degrees, it is said to be occupying Shatbhisha nakshatra. The purpose of including the above illustration is to bring home a point that Bhogansh is neither an average nor a median value of a nakshatra as once thought by some astronomers.

It is imperative to mention that even these nakshatra or constellations are not fixed ones in true sense. All these illuminating stars as well as our solar system are also revolving around the centre of Parmeshthi Mandal or our galaxy or Milky Way and one such revolution is completed in 30, 84, 48, 000 years or 308.448 million years. Moreover, our solar system along with its family of planets and satellites, is shifting at the rate of 20 km per second towards Abhijit nakshatra or α Lyrae constellation

which is located at 61 degrees 43 minutes and 58 seconds north latitude. Therefore, it is understandable that a map showing the position of nakshatra or constellations say twenty thousand years ago, will be different from the one prepared for today. A similar scenario will exist for nakshatra or constellation map say after twenty thousand years because the disposition of these heavenly bodies will drastically change by that time.

As mentioned earlier, apparently fixed luminary stars of a nakshatra are also revolving around the centre of Parmeshthi Mandal or Milky Way or galaxy though at an extremely slow speed. Therefore, Bhogansh value of Yogtara of a nakshatra keeps on changing with the passage of a time. In other words, nakshatra similarly keep on changing with the passage of Kal or time.

Consequently, various Rishi or scientists have recorded different values of Bhogansh over a period of time. Arya (1998)[11] provided the basis for integrating data sets on some of the view points in this connection that are given in the Table 4.

The Table 4 refers to the astronomical measurement of Bhogansh of various nakshatra taken by Rishi or scientists over a period of time. Bhaskaracharya observed and computed these values whereas modern values are calculated from astronomical observations through powerful radio-telescopes. Variation in data collected by two different agencies in different period of time does not reflect any aspersion on any degree of accuracy but it clearly indicates shift in values due to revolution of nakshatra as mentioned earlier. The least shift or change in values has been experienced by Chitra nakshatra or α Virginis constellation (0 degree and 01 minute) while the highest shift has been recorded by Swati nakshatra or α Bootis or Arcturus constellation (18 degrees and 37 minutes) followed by Vishakha nakshatra or α Libra constellation (11 degrees and 46 minutes). It is striking to record that 77.8% of nakshatra have exhibited less than 5 degree shift in Bhogansh value whereas 18.5% nakshatra demonstrated faster rate of variation. A very high rate of shift in the values of remaining 3.7% nakshatra is noticed.

Table 4: Bhogansh (Sidereal Longitudes) of Yogtara of Nakshatra or Constellations

Sr.No	Nakshatra	Bhogansh Bhaskaracharya	Bhogansh as per Ketaki Grah Ganit	Difference (3 - 4)	Bhogansh as on 1st January 2006	Difference (3 - 6)
1	Ashwini	8	10.06	-2.06	10.07	-2.07
2	Bharani	20	24.04	-4.04	24.21	-4.21
3	Krittika	37.3	36.06	1.24	36.08	1.22
4	Rohini	49.03	45.54	3.49	45.56	3.47
5	Mrigsheera	63	59.54	3.46	59.51	3.49
6	Ardra	67.02	64.54	2.48	64.54	2.48
7	Punarvasu	93	89.24	3.76	89.21	3.79
8	Pushya	106	104.54	1.46	108.29	-2.29
9	Ashalesha	109	109.48	-0.48	108.29	0.71
10	Magha	129	126	3	125.58	3.42
11	Poorv Phalguni	144	139.26	4.74	137.28	6.72
12	Uttar Phalguni	155	147.48	7.52	147.46	7.54
13	Hasta	170	169.36	0.64	169.36	0.64
14	Chitra	180	180	0	179.59	0.41
15	Swati	199	180.24	18.76	180.23	18.77
16	Vishakha	213	207.12	5.88	201.14	11.86
17	Anuradha	224	218.42	5.58	218.43	5.57

Sr.No	Nakshatra	Bhogansh Bhaskaracharya	Bhogansh as per Ketaki Grah Ganit	Difference (3 - 4)	Bhogansh as on 1st January 2006	Difference (3 - 6)
18	Jyeshtha	229	225.54	3.46	225.54	3.46
19	Moola	241	239	2	240.44	0.56
20	Poorv Shad	254	250.42	3.58	250.43	3.57
21	Uttar Shad	260	258.48	1.52	258.32	1.68
22	Shravan	280	277.54	2.46	277.55	2.45
23	Dhanishtha	290	296.05	-6.05	292.29	-2.29
24	Shatbhisha	320	317.42	2.58	317.43	2.57
25	Poorvabhadrapad	326	330.42	-4.42	329.38	-3.38
26	Uttarbhadrapad	337	350.3	-13.3	345.18	-8.18
27	Revati	359.5	359.18	0.32	356.01	3.49

Rashi or Signs

As mentioned earlier, Rishi or hermits also divided an ellipsoid or circle called Kal Chakra or Time ellipsoid in 360 degrees. In addition to this division, they divided the Kal Chakra into twelve segments of 30 degrees domain which were considered to be 12 spokes of Time ellipsoid.

Dvadasharam na hi tajjaraye varvarti chakrama paridyamritasya
Aa putra agne mithunso atra saptashatani vinshatiashcha tasthuh[12]

The above Richa or couplet from Rig Ved states that Kal Chakra or Time ellipsoid comprising 12 segments (each segment of 30 degrees domain) revolves around *Deyu lok* or luminary world and never gets degenerated. Oh Agni or fire! 720 sons (a metaphor for 360 days and 360 corresponding nights) ride over this Time ellipsoid.

The following Table 5 incorporates important data pertaining to rashi or signs.

Mesh or Aries occupies first 30 degrees of the zodiac when counted from the east. The east has been selected by our Rishi as an arbitrary reference point since there are no such reference points available on Time ellipsoid, Its shape resembles that of a ram. Similarly, characteristic of each rashi or sign is given in the above Table so that one can easily grasp it.

In the tropical zodiac, the following pairs of rashi or signs on any geographical latitude on the Earth are equal in time duration:-

- Mesh or Aries and Meen or Pisces
- Rishabh or Taurus and Kumbh or Aquarius
- Mithun or Gemini and Makar or Capricorn
- Karak or Cancer and Dhanu or Sagittarius
- Simha or Leo and Vrishchik or Scorpio
- Kanya or Virgo and Tula or Libra

Table 5: Characteristics of Rashi or Sign

Sr.No.	Rashi	Sign	Sidereal longitude	Physical appearance of a Rashi or a Sign
1	Mesh	Aries	0.00 - 30.00	A ram
2	Rishabh	Taurus	30.00 - 60.00	A bull
3	Mithun	Gemini	60.00 - 90.00	A human couple - male holding a club in his hand and a female, a veena (a stringed musical instrument).
4	Karak	Cancer	90.00 - 120.00	A crab
5	Simha	Leo	120.00 - 150.00	A lion
6	Kanya	Virgo	150.00 - 180.00	A girl in a boat holding a sheaf of corn in one hand and fire on the other hand.
7	Tula	Libra	180.00 - 210.00	A man holding scale in one hand
8	Vrishchik	Scorpio	210.00 - 240.00	A scorpion
9	Dhanu	Sagittarius	240.00 - 270.00	A man holding a bow and arrow in one hand with a body of a horse
10	Makar	Capricorn	270.00 - 300.00	In a form, first half represents the head of a deer and later half, a crocodile.
11	Kumbh	Aquarius	300.00 - 330.00	A man holding empty pitcher on his shoulder
12	Meen	Pisces	330.00 - 360.00	Two fishes with their heads pointing in opposite direction

Time duration of the following sub-group amongst all the rashi or signs remains equal on the geographical equator:-

- Mesh or Aries and Kanya or Virgo
- Rishabh or Taurus and Simha or Leo
- Mithun or Gemini and Karkat or Cancer

As one goes in higher geographical latitude regions that lie away from the equator, the time duration of Mesh or Aries, Rishabh or Taurus and Mithun or Gemini gradually diminishes whereas those of Karak or Cancer, Simha or Leo and Kanya or Virgo goes on increasing correspondingly. Therefore, decrease in time duration of Mesh or Aries, Rishabh or Taurus and Mithun or Gemini is duly compensated by corresponding increase in duration of Kanya or Virgo, Simha and Karkta or Cancer respectively.

These rashi or signs have been subjected to many types of classifications. For instance, Mesh or Aries, Karak or Cancer, Tula or Libra and Makar or Capricorn are known as Char or moveable rashi or sign; Rishabh or Taurus, Simha or Leo, Vrishchik or Scorpio and Kumbh or Aquarius as sthir or fixed and Mithun or Gemini, Kanya or Virgo, Dhanu or Sagittarius and Meen or Pisces as dvisvabhav or common rashi or signs. Moreover, other classifications do exist that are not being discussed here due to paucity of space.

Vedic Rishi or scientists further integrated various nakshatra or constellations with rashi or signs of Kal Chakra or Time ellipsoid. As discussed earlier, each nakshatra has further been divided into 4 segments (13 degrees 20 minutes divided by four = 3 degrees 20 minutes) called Pad or Charan or Quarter. Consequently, 108 Pad or Quarters are found to be present in all 27 nakshatra (27 x 4=108). These nakshatra or constellations have further been integrated with all 12 rashi or signs of Kal Chakra or Time ellipsoid. A segment of four rashi or signs contains nine nakshatra or constellation and three such segments account for the entire Kal Chakra.

Vedic Rishi or sages undertook above mentioned reckoning from the beginning of Srishti or creation of the Cosmos and the same

knowledge was passed on to scientists or Rishi of younger generation. At the beginning of a Mahayug (a mega-level time unit), spring or vernal equinox coincided with Ashwini or Arietis nakshatra or constellation. Hence, Ashwini nakshatra or β Arietis constellation was taken as the first nakshatra or constellation for any reckoning. Modern scientists also follow the same sequence of 27 nakshatra. Following Table 6 demonstrates the relationship of different rashi with nakshatra.

It is quite clear that every rashi or sign contains 9 Charan or Quarters of nakshatra or constellations having a domain of 3 degrees and 20 minutes each (3° 20' x 9 = 300). All twelve rashi are further divided into 3 segments of four rashi each. In 1st segment, four rashi namely Mesh, Rishabh, Mithun and Karak are included. In 2nd segments, next four rashi in sequence or Simha, Kanya, Tula and Vrishchik are grouped. Finally, in 3rd segment of remaining four rashi viz. Dhanu, Makar, Kumbh and Meen are included. For example, in rashi of 1st segment, Mesh rashi or Aries sign encompasses 4 Charan of Ashwini nakshatra or β Arietis constellation, 4 Charan of Bharani or 41 Arietis and 1 Charan of Krittika or η Tauri constellations. In Rishabh rashi, 3 Charan of Krittika or η Tauri, 4 Charan of Rohini or α Tauri and 2 Charan of Mrigsheera or λ Orionis constellations are included. In third rashi or Mithun, there are 2 Charan of remaining Mrigsheera or λ Orionis, 4 Charan of Ardra or α Orionis and 3 pad of Punarvasu or β Germinorum constellations. Finally, fourth rashi of this segment or Karak possesses 1 pad of Punarvasu or β Germinorum, 4 pad of Pushya or δ Cancri and 4 pad of Ashalesha or ε Hydrae constellations. In this way, rashi or signs of 2nd and 3rd segments follow similar sequence of relationship with nakshatra as described above that have been clearly demonstrated in Table 6.

Having clearly understood about nakshatra or constellation and rashi or signs, the reader would now appreciate the role these heavenly bodies play in deciphering various elements of Kal Ganana or Time Reckoning. These will be discussed exhaustively at appropriate place in later chapters.

Table 6: Rashi or Sign Integration with Nakshatra or Constellation

Sr.No.	Rashi	Domain in Time Ellipsoid	Inter-relationship of Rashi with Nakshatra
		o ' o '	
1	Mesh/Aries	0.00 - 30.00	Ashwini 4 Pad,Bharani 4 Pad & Krittika 1 Pad
2	Rishabh/Taurus	30.00 - 60.00	Krittika 3Pad,Rohini 4Pad & Mrigsheera 2 Pad
3	Mithun/Gemini	60.00 - 90.00	Mrigsheera 2Pad,Ardra 4Pad & Punarvasu 3Pad
4	Karak/Cancer	90.00 - 120.00	Punarvasu 3Pad,Pushya 4Pad & Ashalesha 4Pad
5	Simha/Leo	120.00 - 150.00	Magha 4Pad, Poorva Phal. 4Pad & Uttar.Phal.1Pd
6	Kanya/Virgo	150.00 - 180.00	Uttar Phalguni 3 Pad,Hasta 4Pad& Chitra 2Pad
7	Tula/Libra	180.00 - 210.00	Chitra 2 Pad,Swati 4Pad & Vishakha 3 Pad
8	Vrishchik/Scorp.	210.00 - 240.00	Vishakha 1Pad,Anuradha 4Pad& Jyeshtha 4Pad
9	Dhanu/Sagittar.	240.0 - 270.00	Moola 4Pad,PoorvaShadh 4Pad & Uttar.Shad.1Pd
10	Makar/Capricorn	270.00 - 300.00	Uttar Shad 3Pad,Shravan 4 Pad & Dhanishtha 2Pd
11	Kumbh/Aquarius	300.00 - 330.00	Dhanishtha 2Pad,Shatbhisha 4Pad & Poorv.Bhad.3 Pad
12	Meen/Pisces	330.00 - 360.00	Poorv Bhadrapad 1Pd,Utt.Bhad.4Pd & Revati 4Pd

4.

SAUR MANDAL OR SOLAR SYSTEM

Rishi who can be described in modern parlance as Bhartiya Vaigyanik or Indian scientists studied in depth those heavenly bodies that are particularly visible to the naked eye such as star or Surya or the Sun, *grah* or planets like Prithivi or the Earth, Mangal or the Mars, Budh or the Mercury etc. and *upgrah* or satellite like Chandra or the Moon. These planets or *grah* and satellites or *upgrah* are found parked around Surya or the Sun and constitute its family which is known as Saur Mandal or Solar System. There are numerous solar systems that have been discerned in our own and adjoining galaxies. In our Saur Mandal or solar system, these planets are helio – centric or Surya or the Sun is stationary and all other planets revolve around it along respective orbits. This concept was contrary to the view held by western scientists and Roman Catholic Church who believed that our solar system was geo-centric i.e. the Earth is stationary and all other planets including the Sun revolve around it till Newton proved it otherwise and supported ancient Bhartiya or Indian concept.

Now, all modern scientists have accepted the concept propounded by Vedic Rishi that our solar system is helio – centric one. From time in antiquity, scientists have been trying to study various planets of our solar system. Various Rishi discovered the properties of planets like their motion, revolution and other parameters. Consequently, the planets were named after them. For example, Surya, Chandra etc. were the names of Rishi who delved into the various scientific

aspects of the Sun and Moon etc. The astronomical disposition of different heavenly bodies of our solar system is enumerated below:-

Surya or the Sun - Budh or the Mercury - Shukra or the Venus - Prithivi or the Earth - (Chandra or the Moon) - Mangal or the Mars - Brihaspati or the Jupiter - Shani or the Saturn - Uranus - Neptune - Pluto.

Therefore, our Saur Mandal or Solar System consists of 9 *grah* or planets, more than 130 *upgrah* or satellites, a very large number of small bodies known as comets and asteroids and inter – planetary medium. The cross section of our Saur Mandal or solar system reveals that Surya or the Sun, Budh or Mercury, Prithivi or Earth, Shukra or Venus and Mangal or the Mars are located in inner solar system. The main asteroid belt lies confined between the orbits of Mangal or the Mars and Brihaspati or the Jupiter. On the other hand, *grah* or planets of outer solar system are Brihaspati or the Jupiter, Shani or the Saturn, Uranus, Neptune and Plato.

Automap gatirnaustah pashyatyanchalam vilomangam yadwat
Achalani bhanti tadwat samapaschchimgani langkayam[13]

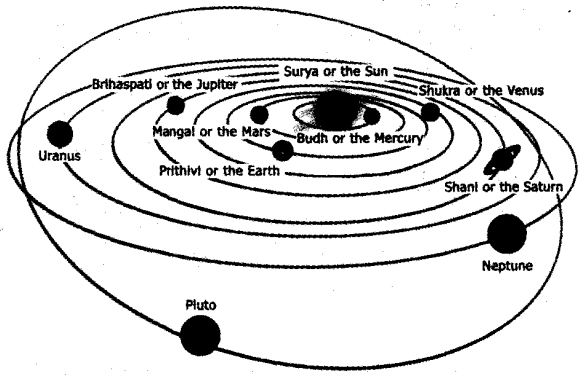
While sailing on a boat, one observes banks shifting backwards; similarly nakshatra or constellations are fixed but their motion is discernible. Actually it is Prithivi or the Earth that rotates around its polar axis.

The orbits of seven planets have been described as Paridhi in Yajur Ved (3.1).

Saptasyasana pridhayaha[14]

The orbits along which these planets revolve around the Sun are known as ecliptics though all except that of the Mercury

and the Pluto are very nearly circular. The orbits of the planets are more or less parked in the same plane which is defined by that of the Earth. The ecliptic of Prithivi or the Earth is inclined only 7 degrees from the plane of the equator of the Sun. However, the inclination of 17 degrees in the orbit of Pluto from the plane of the ecliptic is the highest amongst all planets. This peculiar behaviour of Pluto has forced astronomers to believe that yet another big planet in our solar system exists farther beyond Pluto whose gravitational pull is forcing the orbit of Pluto to behave into a naughty manner. The planet under reference is yet to be discovered. All these planets orbit in the same direction i.e., counter-clockwise while looking down from above the north pole of the Sun. Moreover, all planets also rotate around their respective axis in the same direction except three planets namely the Venus, Uranus and Pluto.



Solar System

At this stage, it will be better if some means are devised to completely apprehend our Saur Mandal or Solar System. Hence, in order to visualize the relative sizes in the solar system, it is better if one perceives a model in which everything is reduced by a factor of a billion or 100 crores. Consequently, Surya or the Sun would be 1.5 meters in diameter or about the height of a man and posited 150 meters away from the Earth.

The size of Prithivi or the Earth would be about 1.3 cm in diameter or the size of a grape. Chandra or the Moon would be located 30 cm away from the Earth. Brihaspati or the Jupiter would be 15 cm in diameter or the size of a banana and located nearly 750 m away from the Sun. The size of Shani or the Saturn would be that of an orange that lies 1.5 km away while the Uranus and Pluto would be of the size of a lemon which are 3 and 4.5 km away respectively. A man on this scale will be the size of an atom. Nonetheless, the nearest star outside our solar system would be 40,000 km away on this scale.

There are numerous smaller bodies that inhabit our solar system which are the satellites of various planets. Moreover, a large number of asteroids which are small rocky bodies that orbit around the Sun and are posited mainly between the Mars and Jupiter but are found elsewhere also. The comets are small icy bodies that visit and go from the inner parts of the solar system in highly elongated orbits that lie at random orientation to the ecliptic. Many small icy bodies are also found beyond the Neptune in the Kuiper belt. Planetary satellites orbit in the same manner as the planets and approximately in the plane of the ecliptic with some exceptions. However, this phenomenon is not true for asteroid and comets.

The planets including satellite of the Earth known as the Moon have been utilized by our Rishi for undertaking Kala Ganana or Time Reckoning. It is, therefore, essential to understand the vital characteristics of these heavenly bodies of our solar system.

Surya or the Sun

Surya or the Sun is the most prominent feature of our Saur Mandal or solar system. In Ved, it has been described to be sitting on a chariot having seven horses which is a metaphor to explain seven colours of the light or Vibgyor. Its light or energy sustains life on this Earth. Consequently, Rishi have called it Savita or giver of life. Surya dominates and dwarfs its family of

nine planets. It is the only star around which all the planets revolve.

Surya or the Sun is the largest object which contains approximately 98% of the total mass of the solar system which works out to be 1.989e30 or 1.989 x 10^{30} kg. In other words, if 1 is the mass of the Earth; it would take 3, 32, 830 Earths to equal the mass of the Sun. It is interesting that 109 Earths would be required to fill the disc of the Sun and its interior could hold over 1.3 million or 13 lakh Earths in its folds.

The Sun is not a solid mass but it is composed of gaseous matter packed in a series of layers. These layers emanate positive magnetic rays that join the negative magnetic property of the Earth so that heat and light are generated. The outer visible layer of the Sun is called photosphere that possesses a temperature of 6000 degrees Celsius. This layer has a mottled appearance due to turbulent eruptions of energy at the surface. Solar energy is created deep within the core of Surya or the Sun. Unbelievably enormously high temperature or 15 million or 1 crore and 50 lakh degrees Celsius and pressure or 340 billion times of atmospheric pressure of the Earth at sea level; are so intense in the core that nuclear reaction occurs. This reaction causes four protons or hydrogen nuclei to fuse together to form one alpha particle or helium nucleus. This alpha particle is about 0.7% less massive than four protons. The difference in mass is expelled as energy and is carried to the surface of the Sun through convection process where it is released as light and heat. It takes a million or 10 lakh years for the generated energy of the core to reach its surface. It may be mentioned that every second, 700 million tons of hydrogen are converted into helium ashes. In the process, 5 million tons of pure energy is released. Therefore, the Sun is becoming lighter with passage of time.

Some additional terminology concerning Surya or the Sun will help us understand its behaviour properly. The chromosphere

lies above photosphere. Solar energy passes through this region on its way out from the centre of the Sun. Faculae and flares originate in the chromosphere. Faculae are bright luminous hydrogen clouds which form above regions where sunspots are about to be formed. Flares are bright filament of hot gas that emerges from sunspot regions. Sunspots are dark depressions on the photosphere with a typical temperature of 4000 degrees Celsius. Corona is the outer part of atmosphere of the Sun. In this region, prominences appear. Prominences are immense clouds of glowing gas that erupts from upper chromosphere. The outer region of corona stretches far into space and consists of particles traveling slowly away from the Sun. Corona can be seen only during total solar eclipses.

Surya or the Sun appears to have been active for 4.6 billion years and has enough fuel to go on for another 5 billion years or so. At the end of its life, the Sun will start to fuse helium into heavier elements and begin to swell up; ultimately growing so large that it will swallow the Earth. After a billion years of having become as a red giant, it will collapse into a white dwarf which is the final end product of a star like ours. It may take a trillion years to cool off completely.

Despite relatively small sizes and enormous distances of empty space that separates all planets from one another and the Sun, Surya keeps its planets under its strict control and discipline like a hard task master. Revolving around it continuously in elliptical orbits, these planets are held near the Sun by the pull of gravity and preventing them from being sucked into the Sun by their speed with which they revolve in the space. The closer the planet to the Sun faster is their movement. Budh or the Mercury is the nearest planet from the Sun that lies at an average distance of 57.9 million or 5 crore 79 lakh km from Surya. It takes 88 days to complete its one revolution around the Sun at a speed of 48 km per second. On the contrary, Pluto is the farthest planet from the Sun, which is parked at an average distance of 5900 million km. It takes just over 248

years at a speed of 4.8 km per second to complete one revolution around the Sun.

The radius of Surya or the Sun is 13, 92, 530 km that is 109 times than that of equatorial one of the Earth. The distance of the Sun from the Earth is 149.6 million or 14 crore and 60 lakh kilometers. Its rays reach the surface of Prithivi or the Earth in 8 minutes and 18 seconds. Its rotation period at the surface varies from approximately 25 days at the equator to 36 days at the poles.

In geo – centric model of our solar system, its daily motion varies from 57 minutes 11 seconds to 1 degree 1 minute and 9 seconds. Surya transits one rashi in approximately one month and one nakshatra in approximately 14 days.

Budh or the Mercury

Budh or the Mercury is the nearest planet to the Sun and is the eighth largest one. It has been visited by only one space craft, Mariner 10. It flew three times in 1974 and 1975 A.D. Only 45% of its surface has been mapped. A new discovery – class mission to the Mercury, Messenger, was launched by NASA in 2004 A.D. that will orbit Budh or the Mercury in 2011 A.D. after several flybys.

The orbit of Budh is highly eccentric one. At perihelion, it is only 46 million or 4 crore and 60 lakh kilometers away from the Sun but at aphelion, it gets extended to 70 million or 7 crore kilometers. The position of the perihelion precesses around the Sun at a very slow rate. Budh or the Mercury is the only planet in our solar system known to have an orbital/ rotational resonance with a ratio other than 1: 1. It is known to rotate three times in two of its years. Temperature variations on the Mercury are the most extreme in our solar system ranging from 90 K to 700 K.

This planet is in many ways similar to Chandra or the Moon. Its

surface is heavily cratered that are very old. However, Budh is much dense than the Moon or 5.43 g /cm^3 as compared to 3.34 g /cm^3 of the Moon. It is the second densest major planet in Saur Mandal or solar system after the Earth. The interior of Budh is dominated by a large iron core whose radius varies from 1800 to 1900 km. Some of its core may be in a molten state. The silicate outer shell is only 500 to 600 km thick.

Budh or the Mercury has a very thin atmosphere comprising atoms blasted off its surface by the solar winds. Since Budh is so hot, these atoms escape into space. Unlike the atmospheres of the Earth and Venus, it is constantly being replenished in the Mercury. Its surface exhibits enormous escarpments, some up to hundreds of kilometers in length and as much as 3 kilometer in elevation. Some cut through the rings of craters and other features in such a manner as to indicate that they were formed by compression.

One of the largest features on the surface of Budh or the Mercury is Calories Basin which is about 1300 km in diameter. It is thought to be similar to the large basin known as Maria on Chandra or the Moon. Like lunar basin, it was probably caused by a very large impact early in the history of the solar system. In addition to heavily cratered terrain, the Mercury has also regions of smooth plains. Some may be the result of ancient volcanic activity but some may be the deposits ejected from impacts of creation of craters. Amazingly, recent radar observations on north pole of the Mercury, exhibit evidences of water ice in the protected shadows of some craters. Budh has a small magnetic field whose strength is hardly 1% of that of the Earth.

It is interesting to note that Budh takes as much time to rotate around its axis as the one taken by it to complete one revolution. Consequently, one half of the Mercury will ever receive solar rays and light whereas the remaining half will always remain in darkness away from the Sun. Therefore, that

half of the Mercury facing the Sun will always remain lighted and extremely hot while the other half that remains away from the Sun always possesses very low temperature and darkness for ever.

Budh or the Mercury is one of the inferior planets and lies nearest to Surya or the Sun as stated earlier. It revolves around the Sun along its highly eccentric orbit at the rate of 48 km per second, in 87.969256 days or 87 days, 23 hours, 15 minutes and 16 seconds or nearly 88 days. Its mean distance from Surya is 57.9 million or 5,79,00,000 kilometers. Moreover, its maximum distance from Prithivi or the Earth is 222 million or 22, 20, 00,000 kilometers while its minimum value has been calculated as 79.6 million or 7,96, 00,000 kilometers. The diameter of the Mercury is nearly 4880 km and its mass is 3.30e23 or 3.3 x 10^{23} kilograms.

Budh or the Mercury is visible to the naked eye an hour before the sunrise and an hour after the sunset. It always remains within 27 degrees from the Sun, and thereafter, it changes motion. In geo – centric model, its daily motion varies from + 0.03 minute to 2 degrees and 11 minutes. It travels one rashi or sign in 25 days. Since Budh moves faster than the Sun (in geo – centric model), it sets in the east and rises in the west. Whenever it is vakri or retrograde, the Mercury rises in the east and sets in the west. It becomes asta or combust if it is parked in retrograde situation within 12 degrees from the Sun and 13 degrees in direct motion. It gets in retrograde motion while placed in the 2nd rashi or sign from the Sun and direct state when posited in 12th rashi or sign from Surya. Further, it remains in direct motion for 92 days and retrograde for 23 days. In direct motion, Budh remains in udita or normal condition for 37 days and combust for 36 days. In case posited in retrogression, it remains udita or normal for 33 days and combust for 16 days. After a lapse of 3 months, 24 days, 1 Ghati and 12 Pal, it returns to its original sequence of normalcy, combustion, retrogression and direct motion; and

this period is termed as Yuti Kala. Thereafter, it follows yet another cycle of similar conditions of retrogression combustion etc. The Mercury gets retrograded thrice during the course of one year.

Shukra or the Venus

Vedic Rishi called this planet as Vena but later on it was known as Shukra or the Venus. It is the second planet from the Sun which is sixth largest one amongst all the planets. It is the brightest object in the sky except for the Sun and Chandra or the Moon. Some call it as the Morning star and others describe it as the Evening star. It is also one of the inferior planets and shows phases when viewed with a telescope. The first spacecraft to visit Shukra was Mariner 2 in 1962. It was subsequently visited by more than 20 such spacecrafts.

The rotation of the Venus is somewhat unusual. It is very slow or its one rotation or one day is equal to 243 Earth days. In addition, the period of rotation and its orbit are synchronized in such a way that it always presents the same face towards the Earth when two planets are at their closest approach. Shukra or the Venus is sometimes regarded as the Earth's sister planet. The Venus is only slightly smaller than the Earth because it incorporates 95% of diameter and 80% of the mass of the Earth. A few craters indicating young surfaces and similar densities and chemical composition are observed in both the planets. Therefore, it was thought that below its dense clouds, the Venus might be very Earth like and might have life but detailed study of the Venus reveals that in many important ways it is radically different from the Earth.

The atmospheric pressure at the surface of the Venus is 90 atmospheres which works out to be almost the same as the pressure at a depth of a km in an ocean of the Earth. It is composed of mostly carbon dioxide. There are several layers of clouds many kilometers thick composed of sulphuric acid ($H2SO_4$). These clouds completely obscure our view of the

surface from the Earth. This dense atmosphere produces a run – away greenhouse effect that raises surface temperature of the Venus by about 400 degrees to over 740 K that is hot enough to melt lead. It is interesting to record that surface of the Venus is actually hotter than that of the Mercury despite being nearly twice as far from the Sun. There are strong winds that blow at the speed of 350 kilometers per hour at the cloud tops but winds at the surface are very slow, no more than a few kilometers per hour.

Most of the surface of Shukra consists of gently rolling plains with little relief. There are also several broad depressions. Lava flows have also been discovered over there. Recently announced findings indicate that the Venus is volcanically active only on a few spots otherwise geologically it is rather quiet for the past few million years. The oldest terrain on the Venus seems to be about 800 million years old. Extensive volcanism at that time wiped out the earlier surface from early in the history of the Venus. The interior of the Venus is probably very similar to that of the Earth; an iron core about 3000 km in radius and a molten rocky mantle comprising majority of the planet. Shukra has no magnetic field perhaps due to its slow rotation.

Its diameter is 12,103.6 km and mass works out to be 4.869e24 or 4.869×10^{24} kilograms. Shukra or the Venus completes one revolution around the Sun along its almost circular orbit in 224.7008 days or 224 days, 16 hours 20 minutes and 19 seconds. Its mean distance from the Sun is 108.2 million or 10 crores 82 lakh kilometers. Nevertheless, its maximum distance from the Earth is 260.9 million or 26 crore and 9 lakh kilometers and its minimum distance is 41.7million or 4 crore 17 lakh kilometers. Its daily motion varies from 0 degree and 02 minutes to 1 degree and 15 minutes.

Shukra also remains confined within 45 degrees from the Sun and thereafter, it changes its motion. It remains in direct motion

for one year and in vakri or retrograde state for the same period. Therefore, it transits twelve rashi or signs in 409 days in direct and in 324 days in retrograde motion. Owing to faster motion than Surya, it rises in the west and sets in the east. Therefore, it is known as Evening Star that remains visible in the sky for 3 hours and 12 minutes. In retrograde condition, the Venus rises in the east and sets in the west.

Shukra or the Venus becomes asta or combust when posited 9 degrees from the Sun in direct motion and 8 degrees in retrogression state. Consequently, it remains asta or combust for 70 days if parked in direct motion and 10 days in retrogression state. Moreover, it remains in Udita or normal condition for 250 days while posited in direct state and 248 days when parked in retrogression state. It occupies 510 days in direct motion and 45 days in retrograded condition. It gets retrograded when posited in the second rashi or sign from the Sun and acquires atichar characteristic or accelerated motion while transiting 12^{th} rashi or sign from the Sun. Also, it follows almost uniform motion while traveling in 3^{rd} and 11^{th} rashi or signs occupied by the Sun. Its Yuti kala is 1 year, 7 months, 5 days, 1 hour and 52 minutes. Thereafter, previously described sequence of direct – retrograde, Udita – asta etc. cycle begins.

Prithivi or the Earth

Prithivi or the Earth is the only planet that sustains biological life. It is the third planet from the Sun and is fifth largest one. Prithivi is divided into several layers which have distinct chemical and seismic properties. The crust varies considerably in thickness from 0 to 40 km depth which is thinner under the oceans and thicker under continents. The inner core and crust are solid; the outer core and mantle layers are semi-plastic or semi fluid in nature. The various layers are separated by discontinuities which are discerned very clearly in seismic data. The best known is Mohorovicic discontinuity that lies between the upper crust and upper mantle.

The Earth is the densest major body on the solar system. The total mass of the Earth is 5.972e24 or 5.972 x 10^{24} kilograms and most of it lies in mantle and the rest in the core. The core is probably composed primarily of iron and nickel though it is possible that lighter elements may be present too. Temperature at the centre of the core may be as high as 7500 K or hotter than the surface of the Sun. The lower mantle consists of probably mostly silicon, magnesium and oxygen with some iron, calcium and aluminum. The upper mantle comprises mostly olivine and pyroxene minerals that contain iron/magnesium. silicates, calcium and aluminum. This information has been obtained from seismic techniques. However, samples of upper mantle do arrive on the surface of the Earth as lava from volcanoes but majority of the interior of the Earth is inaccessible. The crust is made up primarily of silicon dioxide, its crystalline variant being quartz mineral and other silicates like feldspars, a common mineral.

Unlike other terrestrial planets, crust of the Earth is divided into several separate solid plates which float around independently on top of the hot mantle below. Plate tectonics is the theory that describes this phenomenon. It is characterized by two processes: spreading and subduction. Spreading occurs when two plates move away from each other and new crust is created by upwelling of magma from interior portion of the Earth. Subduction occurs when two plates collide with each other and edges of one slide beneath the other and ends up being destroyed in the mantle. There is also transverse motion at some plate boundaries like San Andreas Fault in California and collision between continental plates like India plate having collided into the Asia plate. Hence, there are 8 major and 20 minor plates recorded on the globe.

The surface of the Earth is very young in age. In a relatively short period of 5 million or 50 lakh years or so in geological parlance, erosion and tectonic processes destroy and recreate

most of surface of the Earth and thereby eliminate almost all traces of earlier geological surface history. The Earth is 4.5 to 4.6 billion years old but the oldest known rocks are nearly 4 billion or 400 crore years old but the rocks older than 3 billion years are generally very rare. Nevertheless, the oldest fossil of an organism is less than 3.9 billion years old. However, modern geology has no record of critical period when life was first getting started.

70.8% of the surface of Prithivi or the Earth is covered with water. The Earth is the only planet on which water can exist in liquid form on its surface; though there may be liquid ethane or methane in Titan's surface and liquid water beneath the surface of Europa. Liquid water is, of course, essential for sustaining biological life. The heat capacity of oceans is also very important in keeping relatively stable the temperature of the Earth. Liquid water is also responsible for most of erosion and weathering of continents of the Earth, a process unique in the solar system today.

The atmosphere of Prithivi contains 77% nitrogen, 21% oxygen with traces of Aragon, carbon dioxide and water. There was probably a very much larger amount of carbon dioxide in the atmosphere of the Earth when it was first formed but it has since been almost all incorporated into carbonates rocks like limestone etc. and to lesser extent dissolved into oceans and consumed by living plants. Plate tectonics and biological processes now maintain a continual flow of carbon dioxide from atmosphere to various "sinks" and back again. The tiny amount of carbon dioxide resident in the atmosphere at any time is very important to the maintenance of temperature of the surface of the Earth via greenhouse effect. The greenhouse effect raises the average temperature by about 35 degrees Celsius above what it would otherwise be (from frigid – 20 degrees Celsius to a comfortable + 14 degrees Celsius); without it the oceans would freeze and biological life, as we know, would not survive. The presence of free oxygen is quite

remarkable from a chemical point of view. Oxygen is a very reactive gas and under "normal" circumstances would quickly combine with other elements. The oxygen in atmosphere of the Earth is produced by biological processes. Therefore, it is quite clear that without life, there would be no free oxygen.

The Earth has a moderate magnetic field produced by electric currents in the outer core. The interaction of the solar winds with the magnetic field and upper atmosphere of the Earth causes auroras. Irregularities in these factors cause magnetic poles to move and reverse relative to the surface. The geomagnetic North Pole is currently located in north Canada (the geomagnetic North Pole is the position on the Earth's surface directly above South Pole of Earth's field). The magnetic field of the Earth and its interaction with the solar wind also produces the Van Allen radiation belts, a pair of doughnut shaped rings of ionized gas or plasma trapped in orbit around the Earth. The outer belt stretches from 19,000 km in altitude to 41000 km whereas inner belt lies between 13000 km and 7600 km in altitude.

Bhaskaracharya, in Siddhant Shiromani described the gravitational force of Prithivi or the Earth in the following Verse:-

Akrishtishaktishcha mahi taya yat khastam guru swamimukhama swashkritya
Akrishyatay tatpatativa bhati samay samantat vakpatativayam khay[15]

Prithivi or the Earth possesses gravitational force. Any bodies or objects posited in sky are pulled down towards it. We observe these objects falling on the Earth. Therefore, the gravitational field of the Earth influences within 80 km of space enveloping it.

The Earth is an ellipsoidal body in which polar region is flattened and equatorial area is broadened. Its polar axis is tilted 23.5 degrees from the normal and Prithivi rotates around it

from west to the east along the equator in 23 hours 56 minutes and 24 seconds or 21600 Asu (1Asu = 4 seconds). A healthy man completes his breathing cycle in one Asu. Thus, a healthy man will breathe 21600 Asu or breathing cycles in an ahoratra or a day. Moreover, an ellipsoid has only 21600 minutes (360 x 60 = 21600). Therefore, Vedic Rishi very systematically correlated how Asu phenomenon sustains human life, behaviour of cosmos and evolution of a day due to the rotation of the Earth. Prithivi or the Earth revolves at the rate of 29.79 km per second around the Sun along its 966 million or 96 crore and 60 lakh km long ecliptic at the rate of 100,000 km per hour in 365.25636 days. It works out to be 365 days, 5 hours, 48 minutes and 56 seconds and one such revolution is known as a Saur Varsh or solar year.

The ecliptic of the Earth is not static but increasing very slowly from the day of its birth at the rate of 1.5 cm per year or 159 m in 10,000 years. Consequently, its revolution time along the ecliptic increases by an hour in 16 million or 1 crore and 60 lakh years. Hence, 1970 million or 197 crore years ago when the Earth was created, it used to revolve around the Sun along its ecliptic in 360 days. Due to this reason, Rishi divided an ellipsoid or a circle into 360 degrees.

The average distance between Prithivi or the Earth and the Sun is 14,95,97,870 kilometers which has been used as an astronomical unit. Its equatorial diameter is 12,756.8 km whereas its polar one is 12,713.8 km. Its equatorial circumference is 40,077 km. The total area of the Earth is 510 million square kilometers in which 29.2% or 149 million square km is occupied by land while remaining 70.8% or 361 million square km contains water. Mass of the Earth is 5.9742e24 or 5.9742×10^{24} kilograms.

True values of obliquity of the ecliptic and nutations in longitudes & obliquity as on 1st January from 1997 to 2006 A.D., [after Lahiri (1997 to 2006) [16]] are given in Table 7.

Table 7: Obliquity in Ecliptic and Nutation Values

Sr. No.	1st Jan.	Obliquity of Ecliptic	Difference	Nutation in Longitude	Difference	Nutation in Obliquity	Difference
		o ' "					
1	1997	23 - 26' - 13.1"	-	+ 1.38"	-	-	-
2	1998	23 - 26' - 12.9"	- 0.2"	- 4.29"	6.07"	-	-
3	1999	23 - 26' - 13.77"	0.87"	- 9.78"	5.49"	- 8.15"	-
4	2000	23 - 26' - 15.68"	1.91"	- 13.92"	4.14"	- 5.76"	2.39"
5	2001	23 - 26' - 18.10"	2.42"	-16.12"	2.28"	- 2.88"	2.88"
6	2002	23 - 26 - 20.57"	2.47"	-16.49"	0.37"	+ 0.06"	2.94"
7	2003	23 - 26 - 23.068"	2.498"	- 15.34"	1.15"	+ 3.024"	2.964"
8	2004	23 - 26 - 25.315	2.247"	- 12.17"	3.17"	+ 5.739"	2.715"
9	2005	23 - 26 - 26.703"	1.388"	- 7.41"	4.76"	+ 7.596"	1.857"
10	2006	23 - 26 - 27.019"	0.316"	-1.99"	5.42"	+ 8.38"	0.784"

Mangal or the Mars

Mangal or the Mars is the fourth planet from the Earth and seventh largest one. It has ruddy appearance and shines in the night brilliantly that can be easily distinguished. It is sometimes referred as the Red Planet. It looks inconspicuous early morning before sunrise and after sunset when it lies in proximity to the Sun. Whenever Mangal or the Mars shifts away from the Sun, the former shines brilliantly probably more than brightest of the stars namely Sirius. According to ancient legends, the Mars is also called Bhaum or son of the Earth - a metaphor to emphasize its proximity to Prithivi or the Earth.

The first spacecraft to visit Mars was Mariner 4 in 1965. Several others followed including Mars 2, the first spacecraft to lend on the surface of Mars. In 2004, Mars Expedition Rovers namely "Spirit" and "Opportunity" landed on Mangal or the Mars sending back valuable geological data and many pictures.

The orbit of the Mars is significantly elliptical. One result of this property is a temperature variation of about 30 degrees Celsius at sub – polar point between aphelion and perihelion conditions. This phenomenon has influenced climate on Mangal or the Mars. While the average temperature on the Mars is about 218 K or - 55 degrees Celsius, its surface temperature ranges widely from 140 K or - 133 degrees Celsius at the winter pole to almost 300 K or 27 degrees Celsius on the day side during summer.

Although Mangal or the Mars is much smaller in size than the Earth yet its surface area is about the same as land area of the Earth. The Mars has the most highly varied and interesting landforms of any of the planets except for the Earth. Olympus Mons is the mightiest mountain system in our solar system rising 24 km or 78,000 ft above surrounding plain. The base of this mountain system is more than 500 km in diameter and is rimmed by a cliff that is 6 km or nearly 20,000ft high. Tharsis is a massive bulge on the surface of Mangal which is almost

4000 km in length and 10 km in height. Valles Marineris is a group of canyons that are 2 to 7 km deep and 4000 km in length. Hellas Planitia is an impact crater that is 6 km deep and 2000 km in diameter located in southern hemisphere of the Mars. Its northern hemisphere contains plains that are younger in age, lower in height and possess a complex history. On the contrary, southern hemisphere is old in age and incorporates cratered highlands that resemble the surface of Chandra or the Moon. These two are separated by a zone of an abrupt elevation change of several kilometers.

No direct data is available to indicate the nature of interior of the Mars. Indirect evidences reveal that a dense core of about 1700 km in radius exists that is surrounded by a molten rocky mantle that is somewhat denser than that of the Earth and followed by a thin crust. Data from Mars Global Surveyor indicate that its crust is nearly 80 km thick in southern hemisphere and 35 km in northern hemisphere. There is no evidence of plate tectonics on Martian surface. Therefore, hot spots under the crust remain in a fixed position with reference to the surface. This feature along with low surface gravity could account for Tharsis bulge and huge volcanoes. However, there is no evidence of active volcanic activity over its surface in recent past.

The most significant discovery of recent exploration of Mangal or the Mars is identification of erosion activity, large flood plains and small river systems. The age of erosion channel was estimated to be nearly 4 billion years and no younger channels have been discerned. Recent discoveries also include presence of large lakes and oceans.

The Mars contains a very thin atmosphere that has carbon dioxide which is 95.3%, nitrogen (2.7%), Argon (1.6%) and traces of oxygen (0.15%) and water (0.03%). The average pressure on the Martian surface is only about 7 mb that is less than 1% of the one recorded on the surface of the Earth.

However, it is thick enough to support very strong winds and vast dust storms that occasionally engulf the entire *grah* or planet for months. It has permanent ice caps located on both the poles and consists of water ice and solid carbon dioxide or dry ice. The ice caps show a layered structure with alternating layers of ice and variable concentration of dark dust.

A small number of meteorites are believed to have originated from the Mars. First identification of organic compounds in a meteorite of Martian origin was reported in 1996. On the other hand, evidences of ancient micro-organisms from the Martian sample recovered from the Mars were also obtained. However, this evidence does not establish the fact of extra-terrestrial life since the data available is too preliminary. Large but weak magnetic field does exist in various regions of the Mars. This unexpected finding was made by Mars Global Surveyor spacecraft just days after it entered the orbit of the Mars. There are two small satellites called Phobos Hall and Deimos Hall that orbit very close to the surface of Mangal or the Mars.

The Mars revolves around the Sun outside the ecliptic of the Earth, in 686.97982 days or 686 days, 17 hours, 30 minutes and 41 seconds. Its daily motion varies from 15 minutes to + 43 minutes. It rotates around its axis in 24 hours 36 minutes and 22.5 seconds. Its mean distance from the Sun is 227.94 million or 22 crore, 79 lakh and 40 thousand kilometers. The maximum distance of Mangal from the Earth is 400.5 million or 40 crore and 5 lakh kilometers whereas its minimum distance works out to be 55 million or 5 crore and 50 lakh kilometers.

The Mars travels one rashi or a sign in almost 45 days. Mangal or the Mars becomes retrograde when posited 135 degrees away from the Sun. On becoming retrograde, the Mars transits that rashi or sign in 127 days and the following rashi in 15 days. However, it travels a rashi or sign in 45 days when parked in direct motion. It gets asta or combust when posited 17 degrees away from the Sun. It rises in the east and sets in the

west due to its slower motion than that of the Sun. In broader perspective, the Mars remains asta or combust for 120 days, udita or normal for 658 days, retrograde for 76 days, in direct motion for 705 days and acquires atichar or accelerated motion for 15 days. Its Yuti kala is 2 years, 1 month, 19 days, 4 Ghati and 12 Pal.

Brihaspati or the Jupiter

Brihaspati or the Jupiter is the largest planet of Saur Mandal or our solar system and is the fifth one parked from the Sun. It is twice as massive as all other planets put together. It is the fourth brightest heavenly body in our sky after the Sun, Moon and Venus. It is posited far beyond the swarms of asteroids. Even having been located at an enormous distance from the Earth, it appears as a bright object in the night sky. It is brighter than all planets except Shukra or the Venus and Mangal or the Mars. However, it shines brilliantly when located in opposition to both luminaries viz. the Moon and Sun on Poornima or full moon day when it casts its shadow. The planet is visible even in the presence of Chandra or the Moon in sky. It is round in shape but flattened near its poles.

Brihaspati was first explored by Pioneer-10 in 1973, followed by Pioneer – 11, Voyager – 1 & 2 and Ulysses. The spacecraft Galileo has been orbiting the Jupiter for last eight years and is still operational and transmitting valuable data. A gas planet does not possess solid surface and its gaseous material simply gets denser with depth. It has hydrogen (90%) and Helium (10%) with traces of methane, water, ammonia and so called "rock". This composition very closely resemble to that of primordial Solar Nebula from where the entire Saur Mandal or solar system has been derived. Shani or the Saturn has similar composition but lesser hydrogen and helium are observed on the Uranus and Neptune.

Since the data from Galileo's atmospheric probe goes down to nearly 150 km below cloud top, information on interior of

Brihaspati will remain highly indirect. It probably has a core that may contain rocky material whose mass may be equivalent to 10 to 15 times to that of the Earth. Main bulk of the Jupiter lies above the core in the form of liquid metallic hydrogen. This form of hydrogen is possible at pressure exceeding 4 million bars. Metallic hydrogen comprises ionized protons and electrons occurring at far less temperature as compared to the interior of Surya or the Sun. However, hydrogen lies in a liquid state and not in gaseous form at the temperature and pressure of interior of the Jupiter. Liquid hydrogen is an electrical conductor that is the source of magnetic field on the Jupiter. This layer may contain traces of various types of ices. Its outermost layer contains mostly molecular hydrogen and helium in a gaseous state. Its atmosphere that is seen from the Earth is just the top of this deep layer. Carbon dioxide, water, methane etc. are also present in traces. Three distinct layers of clouds are believed to exist that contain ammonia ice, ammonium hydrosuphide and a mixture of ice and water.

Brihaspati or the Jupiter experiences high velocity winds restricted to wide band of latitude. It is interesting to note that winds blow in opposite direction in adjacent bands. Slight temperature and chemical variations between these bands may be responsible for the coloured bands that dominate the appearance of Brihaspati. The light coloured bands are known as zones while dark ones are belts. The data from probe of Galileo exhibit that winds blow at a faster rate (nearly 640 km/hour) and extend down below as far as the probe was able to observe. It is quite likely that these winds may extend down to thousands of kilometers into its interior. Moreover, its atmosphere was also noticed to be turbulent. This phenomenon suggests that winds of the Jupiter are driven in large part by its internal heat rather than inputs from the Sun as in the case of the Earth. Clear colours seen in clouds engulfing the Jupiter are perhaps the result of chemical reactions of trace elements in the atmosphere of the planet that could involve sulphur whose compounds take on wide range

of colours but exact details are not yet known. However, colours correlate with the altitude of clouds. The lowest layer has blue colour that is followed by browns and white with reds occurring at the highest level. Occasionally, lower layers are seen through "windows" or holes found in upper ones.

The Great Red Spot is an oval shaped that occupy an area of 300 million (12000 x 25000 km) square kilometers which is capable of holding two Earths. Infra red observations and the direction of rotation suggest that Great Red Spots is a region of high pressure whose cloud tops are significantly colder than surrounding areas. Similar structures are noticed on the Saturn and Neptune. Brihaspati or the Jupiter radiates more energy into space than it receives from the Sun. The interior of the planet is hot and temperature of its core could be 20,000 K. The heat is not generated by nuclear fusion like in case of the Sun but by Kelvin – Helmholz mechanism and slow gravitational compression of the planet. It possesses a huge magnetic field which is much stronger than that of the Earth. Its magnetosphere extends more than 650 million km that even passes the orbit of the Saturn. Galileo's probe discovered a new intense radiation belt between ring of the Jupiter and uppermost atmospheric layers. This new belt is approximately ten times stronger than Earth's Van Allen radiation belts. Brihaspati has rings like that of the Saturn but they are much fainter and smaller in dimensions. Its rings are dark as compared to that of the Saturn due to very less albido of 0.05 and are composed of small grains of rocky material that contains no ice. Particles in the rings of Brihaspati probably do not stay for long due to atmospheric and magnetic drag. In July 1994, comet Shoemaker – Levy 9 collided with the Jupiter. The debris from collision was visible for nearly one year.

Table 8: Basic Data on Moons of Brihaspati or the Jupiter

Sr.No.	Moon Name	Distance, 000 km	Radius,km	Mass, kg.	Discoverer	Discovery Year
1	Sinope	23,700	18	7.77E+16	Nicholson	1914
2	Pasiphae	23,500	25	1.91E+17	Melotte	1908
3	Carme	22600	20	9.56E+16	Nicholson	1938
4	Ananke	21200	15	3.82E+16	Nicholson	1951
5	Elara	11737	38	7.77E+17	Perrine	1905
6	Lysithea	11720	18	7.77E+16	Nicholson	1938
7	Himalia	11480	93	9.56E+18	Perrine	1904
8	Leda	11094	8	5.68E+15	Kowal	1974
9	Callisto	1883	2400	1.08E+23	Galileo	1610
10	Ganymede	1070	2631	1.48E+23	Galileo	1610
11	Europa	671	1569	4.80E+22	Galileo	1610
12	Io	422	1815	8.94E+22	Galileo	1610
13	Thebe	222	50	7.77E+17	Synnott	1979
14	Amalthea	181	98	7.17E+18	Barnard	1892
15	Adrastea	129	10	1.91E+16	Jewitt	1979
16	Metis	128	20	9.56E+16	Synnott	1979

Brihaspati or the Jupiter possesses 63 known satellites or "moons" as on February, 2004 A.D. It is very gradually slowing down due to tidal drag by the Galilean satellites. In addition, the same tidal forces are changing orbits of the moons that forces them to move further from the Jupiter. A very large number of asteroids and other bodies lie between the orbits of the Mars and Jupiter. The basic data on some of the significant moons is given in Table 8.

It revolves around the Sun along its orbit in 4332.589 days or 11 years, 10 months, 14 days, 20 hours, 02 minutes and 07 seconds. Since its upper portion is not solidified, the period of rotation along its axis is also not uniform for all parts of the planet. Therefore, it spins very fast and completes one rotation in 9 hours and 55 minutes. It is parked in one rashi or sign for 361 days, 01 hour, 10 minutes and 10 seconds and its daily motion varies from 1 minute to 13 minutes. Its mean distance from the Sun is 778.33 million or 778.33e10 or 77 crore, 83 lakh and 30 thousand kilometers. The maximum distance of Brihaspati from the Earth is 968 million or 968e10 or 96 crore and 80 lakh kilometers while its minimum value has been computed to be 587 million or 587e10 or 58 crores and 70 lakh kilometers. Its diameter is 1, 42, 984 or 0.142984e10 kilometers and its mass is 1.900e27 or 1.9 x 1027 kilograms. In other words, Brihaspati is 1200 times larger and 310 times heavier than the Earth.

Brihaspati or the Jupiter becomes retrograde when parked 120 degrees earlier than the Sun and direct in motion when placed similar degrees later than Surya. In retrograde condition, it retraces 12 degrees and remains in that situation for 122 days; thereafter, it becomes direct and remains in that condition for 278 days. As it gets nearer to the Sun, its motion gets accelerated. It rises in the west and sets in the east due to its slower motion than that of the Sun. It stays asta or combust when posited within 11 degrees from the Sun. After remaining asta or combust for 30 days, it remains in udita or normal

condition for 372 days. Its transit in 12 rashi or signs with reference to the one occupied by the Sun, has been very minutely studied by Rishi. It becomes accelerated when posited in 2nd rashi from the Sun, uniform motion in 3rd sign, slow motion in 4th sign, retrograde in 5th and 6th rashi, accelerated retrogression in 7th and 8th rashi, kutila or crooked or slow motion for 3 to 5 days in 9th and 10th rashi and accelerated motion again in 11th and 12th sign. Its Yuti kala is 1 year, 1 month, 3 days and 14 seconds.

Shani or the Saturn

Rishi called it *Shanichar* or a leisurely moving body as compared to other planets. Shani or the Saturn is the sixth planet located away from the Sun and happens to be the second largest one. It is visible to the naked eye in night sky even though it is posited at an enormous distance. It is characterized by three concentric rings that surround Shani. It appears like a blue ball with three yellow rings around it and it is easily distinguishable since it does not twinkle like other heavenly bodies.

The Saturn was first visited by NASA's Pioneer – 11 in 1979 and later by Voyager -1 and 2. Casino, a joint project of NASA/ESA arrived near the Saturn on 1st July 2004 and will orbit Shani for almost four years. The planet has an oblate or flattened outline in which equatorial diameter is 120,536 and polar one is 108,728 kilometer. In order to put in different words, it can be stated that there is almost 10% variation between diameters of equatorial and Polar Regions of Shani which is the result of its rapid rotation and fluid state. The other gaseous planets are also oblate but not to such an extent like the Saturn. It is the least dense amongst all the planets; its specific gravity being 0.7 which is less than that of water.

The Saturn contains, like the Jupiter, almost 75% of hydrogen and nearly 25% of helium with traces of water, methane, ammonia and "rock ". It is similar in composition to primordial solar nebula from which our Saur Mandal was formed. The interior of the Saturn resembles that of the Jupiter; and consists

of rocky core, a liquid metallic hydrogen layer and molecular hydrogen layer. Traces of various "types of ice" are also present. Its interior is hot that is 12000 K at the core; and the Saturn radiates more energy into space than it receives from the Sun. The bands so prominent on the Jupiter are much faint on the Saturn. They are relatively wider near the equator. Shani also shows long – lived ovals and other features common on the Jupiter. Recently, storms have been observed in the equatorial region of the planet.

Two prominent rings A and B and one faint or C are observed from the Earth. The gap between the A and B rings is known as Cassini division. The pictures sent by Voyager show four additional faint rings. The rings of the Saturn are very bright that have an albido value of 0.2 to 0.6 unlike rings of other planets. Although these rings look continuous ones from the Earth yet they are composed of innumerable small particles each in independent orbit. It is quite likely that some of these objects are a few kilometers in size. These rings are extraordinarily thin though they are 250,000 km or more in diameter but they are less than a kilometer thick. Despite their impressive appearance, there is very little material in rings. If these rings were to be compressed into a single body, hardly it would become 100 kilometers across. The ring particles comprise mainly water ice but they also include rocky particles with icy coatings. The outermost ring, known as F – ring, possesses a complex structure that is made up of several smaller rings along which "knots" are visible.

There are complex tidal resonances between some of the moons of Shani and ring systems. However, some of the moons that are known as "shepherding satellites" such as Atlas, Prometheus, and Pandora etc. are clearly important in keeping the rings in place. It has significant magnetic field. The Saturn has 30 named satellites or moons and one has been discovered in 2003 and two in 2004 that are yet un-named. Most of important moons of the Saturn with properties are given in the following Table 9.

Table 9: Moons of Shani or the Saturn

Sr.No.	Moon Name	Distance, 000 km	Radius, km	Mass,kg	Discoverer	Date
1	Phoebe	12952	110	4.00E+18	Pickering	1898
2	Iapetus	3561	730	1.88E+21	Cassini	1671
3	Hyperion	1481	143	1.77E+19	Bond	1848
4	Titan	1222	2575	1.35E+23	Huygens	1655
5	Rhea	527	765	2.49E+21	Cassini	1672
6	Helene	377	16	-	Laques	1980
7	Dione	377	560	1.05E+21	Cassini	1684
8	Calypso	295	13	-	Pascu	1980
9	Telesto	295	15	-	Reitsema	1980
10	Tethys	295	530	7.55E+20	Cassini	1684
11	Enceladus	238	260	8.40E+19	Herschel	1789
12	Miamas	186	196	3.80E+19	Herschel	1789
13	Janus	151	89	2.01E+18	Dollfus	1966
14	Epimetheus	151	57	5.60E+17	Walker	1980
15	Pandora	142	46	2.20E+17	Collins	1980
16	Prometheus	139	46	2.70E+17	Collins	1980
17	Atlas	138	14	-	Terrile	1980
18	Pan	134	10	-	Showalter	1990

Shani or the Saturn revolves around Surya or the Sun along its orbit at a very slow speed and completes one revolution in 10,759.23 days or 29 years, 5 months, 16 days, 23 hours, 16 minutes and 32 seconds. Therefore, it travels one rashi or sign in almost 2.5 years. Moreover, it also completes its rotation in 10 hours, 14 minutes and 24 seconds. Its daily motion varies from 01 minute to 8 minutes. Its equatorial diameter is 120,536 kilometers and mass is 5.68e26 or 5.68 x 10^{26} kilograms. It is, therefore, 734 times heavier than Prithivi or the Earth. Its mean distance from the Sun is 1,429,400,000 or 1429.4 million or 1429.4e6 kilometers. Its maximum distance from the Earth is 1659 million or 1659e6 kilometers while its minimum value is 1253 million or 125 crore and 30 lakh kilometers.

The Saturn remains in retrograde state for 138days while for the remaining period of the year, it travels in direct motion. It daily transits 3 minutes if parked 3 signs preceding that of the Sun and 1 minute if posited 4 rashi or signs preceding the one occupied by Surya. However, it acquires atichar status or an accelerated motion when approaching the sign in which Surya or the Sun is posited. It further becomes retrograde when approaching the end of 4th rashi or sign preceding the one occupied by the Sun. Again, it rises in the west and sets in the east, owing to its mandagati status or decelerated motion as compared to that of the Sun. Shani becomes asta or combust when posited within 15 degrees from the Sun. It stays in asta or combust state for 36 days, udita or normal motion for 340 days, margi or direct state for 238 days and atichar or an accelerated motion for 180 days. Shani or the Saturn travels in sheeghragami state or an accelerated motion when parked in 2nd and 12th rashi from the Sun, samachari or normal motion in 3rd and 11th rashi, mandachari or decelerated motion in 4th rashi, vakri or retrograde motion in 5th and 6th rashi, ativakri or excessive retrogressive motion in 7th and 8th rashi or sign and kutilagati or crooked or slow motion while posited in 9th and

10^{th} rashi or sign from the one occupied by Surya or the Sun. Its Yuti kala is 1 year, 12 days, 01 hour and 26 minutes.

Chandra or the Moon

Chandra or the Moon is the nearest heavenly body from the Earth that is observed in the sky and its disc is the most luminary one. It is the only natural satellite of Prithivi but has been referred as "a planet" in ancient literature just to emphasize its nearness to the Earth, its size and composition. Its impact on Prithivi, animal as well as plant kingdom and human life is well known. For example, tides in oceans and menstruation cycle in human females and many other events and characteristics are universally attributed to this "planet ". Chandra or the Moon is the only other luminary body apart from the Sun. Only one half of lunar disc facing the Sun receives light directly from it that in turn, gets illuminated and reflects the light to the Earth. Hence, the Moon shines only in the reflected light of the Sun. In other words, the Sun is the generator of power that is received by the Moon.

Consequently, Rishi attached very great importance to Chandra and treated it as the second important body apart from the Sun. The angle between the Earth, Moon and Sun changes as Chandra or the Moon orbits around the Earth in almost a month. Consequently, the cycle of various phases of Chandra is noticed. The time between successive Amavasya and new moons is 709 hours which is slightly different from orbital period of the Moon which is measured against stars since the Earth moves a significant distance on its orbit around the Sun during that time.

Chandra or the Moon was first visited by the then Soviet spacecraft Luna – 2 in 1959. It is striking to record that it is the only extraterrestrial body that has been visited by mankind. The first landing on the Moon was on 20^{th} July 1969 and the last one was in December 1972. Moreover, Chandra is the only heavenly body from which rock samples have been brought to

the Earth. Clementine and Lunar Prospector are two spacecrafts mapped Chandra or the Moon extensively in 1994 and 1999 respectively.

The gravitational forces between the Earth and the Moon cause some interesting effects. The most important is Tides. The gravitation attraction of Chandra or the Moon is stronger on the side of the Earth nearest to the Moon and very week on the opposite side. The ocean is not perfectly rigid; it is stretched out along the line towards the Moon. From our perspective on the Earth, two small bulges, one facing towards the Moon and the other directly opposite are discernible. This effect is much stronger in the oceans than in solid crust so that water bulges are higher. Since Prithivi rotates faster than the movement of the Moon on its orbit, these bulges move around the Earth once a day. Thus, two high tides are recorded during the course of a day. It is a much simplified explanation and an actual tide near the coasts is a complicated phenomenon. The entire Earth is not in a fluid state. Its rotation takes the bulges of the Earth slightly ahead of the point directly beneath the Moon. In other words, the force between the Earth and the Moon is not along the line between their centers that produces a torque on the Earth and an accelerating force on the Moon. This phenomenon causes a net transfer of rotational energy from the Earth to the Moon that slows down rotation of the Earth by about 1.5 milliseconds per century and raising the Moon into higher orbit by about 3.8 cm per year.

The asymmetrical nature of this gravitational interaction is also responsible for the fact that the Moon rotates synchronously i.e. it is locked in phase with its orbit so that the same side is always facing towards the Earth. Since the rotation of the Earth is now being slowed down by the influence of the Moon similarly rotation of Chandra was slowed by the action of the Earth but in that case, the effect was very strong. When rotation rate of Chandra was slowed to match its orbital period, there was no longer an off – centre torque on the Moon and a stable

situation was evolved. Eventually, rotation of the Earth will be slowed to match Chandra's period too as is the case with Pluto and Cheron. Chandra appears to wobble a bit due to slight eccentric ecliptic in such a manner that a few degrees of opposite or far side is seen from time to time. Soviet spacecraft Luna – 3 photographed so called dark side of the Moon in 1959.

There is no atmosphere on Chandra or the Moon. It was suggested that there may be water ice in some deep craters near the south pole of the Moon that are permanently shaded. This has now been confirmed by Lunar Prospector spacecraft. Probably, there is ice at the North Pole too. The crust of the Moon is nearly 68 km thick. Beneath the crust, there is a mantle enveloping the core that could be roughly 340 km in radius and contains 2% of mass. The interior of the Moon is no longer active. It is strange that centre of the mass of the Moon is offset from its geometric centre by about 2 km in the direction towards the Earth. Moreover, its crust is thinner towards the side that faces the Earth.

There are two types of terrain on the Moon. First one is old highlands that are heavily cratered and the second one is younger relatively smooth Maria. The Maria consists of nearly 16% of the surface of the Moon, are huge impact craters that were later flooded by molten lava. Most of the surface is covered with regolith, a mixture of fine dust and rocky debris produced by meteorite impact. The Maria is concentrated on the side that faces the Earth. Most of the craters on the side facing the Earth are named after famous figures of history like Tycho, Copernicus, and Ptolemaeus etc. Features on its far side bear modern names like Apollo, Gagarin, and Korolev etc. The Moon also has a huge crater which is known as South Pole – Aitken that is located on the opposite side that is 2250 km in diameter and 12 km deep making it the largest impact basin in the entire solar system.

382 kilograms of lunar rock samples were brought on the Earth under the Apollo and Luna programmes. Most rocks on the surface of the Moon varies from 4.6 to 3 billion years old which bear per chance resemblance with terrestrial rocks that are rarely more than 3 billion years old. Therefore, Chandra provides evidence about early history of the Saur Mandal or solar system that is not available on Prithivi. On the basis of study of lunar rock samples, impact theory concerning origin of the Moon has been widely accepted. The Earth collided with very large object, perhaps as big as size of the Mars, and the Moon was formed from the ejected material. It has no magnetic field at present but palaeo – magnetism has been recorded from lunar rock samples that indicate existence of magnetism in the history of the Moon. Therefore, the surface of the Moon has been exposed to solar winds due to the absence of atmosphere and magnetic field.

The maximum distance of the Moon from the Earth is 40, 48,000 km while its minimum distance is 3, 84,400 km. Its equatorial diameter is 3476 km and its mass has been calculated as 7.35e22 or 7.35 x 10^{22} kilograms. The Moon revolves around Prithivi along its orbit in 27.3216615 days or 27 days, 7 hours, 43 minutes and 11 seconds. It is known as nakshatra or constellation month which is also known as *Bhagan Kala* of Chandra. Its daily motion varies from 11 degrees, 47 minutes and 03 seconds to 15 degrees, 11 minutes and 13 seconds and its mean daily motion works out to be 13 degrees, 10 minute and 35 seconds.

Chandra or the Moon remains in asta or combust condition when it transits within 12 degrees from the Sun. It never becomes vakri or retrograde.

Rahu or Caput Draconis and Ketu or Cauda Draconis

Ancient Indian literature is replete with abundant reference to yet two more "bodies" called Rahu and Ketu. It may be made

clear at this stage that neither of these bodies exists in physical land or gaseous form in our solar system. Therefore, these are merely *Chhaya Grah* or "shadow planets ". These are merely mathematically computed sensitive points. During the course of its revolution, every planet does not follow the path of its ecliptic senso stricto but it deviates in either of the direction; sometimes north of it known as northern latitude and occasionally south of it called southern latitude but never crosses the domain of zodiac. Zodiac is a broad belt of 16 degrees extending 8 degrees on either side of ecliptic in which all the planets of our solar system are situated.

Due to rotation of the Earth around its own axis once a day, the zodiac also appears to revolve on its axis once a day. Chandra or the Moon also experiences this phenomenon. When it travels in the northern latitude during the course of its revolution around the Earth, it crosses the ecliptic that is a sensitive point. This sensitive point is called Rahu or Northern Node or Caput Draconis or Dragon's head. 180 degrees away from this point, Chandra passes the ecliptic during the course of its southern course from north to south. This point is called Ketu or Southern Node or Cauda Draconis or Dragon's Tail.

It is desirable to add that Rahu and Ketu do not possess any mass, weight, body atmosphere etc. It is interesting to record that orbit of the Moon is also inclined to the ecliptic and the Sun, Earth and Moon are not in a straight line on each such intersection. Therefore, no eclipse occurs in above mentioned scenario. Therefore, latitude of the Moon is zero at Rahu and Ketu, as it is posited on its ecliptic. Moreover, Rahu and Ketu are not stationary in space but possess a mean motion of about 18 degrees and 30 minutes per year and take nearly 18 years and 6 months to complete one revolution around the Earth. These *Chhaya Grah* or shadow planets always move in a retrograde motion. Their true and mean locations can be calculated based on where they are posited or where they should had been placed had the motion were uniform.

5.

MICRO AND MACRO LEVELS OF TIME RECKONING OR KAL GANANA

The study of Indian Time Reckoning or Bhartiya Kal Ganana has been organized into two segments exclusively for the sake of this book only in order to get a clear understanding of the subject. It is further emphasized that this grouping is absolutely an arbitrary one which has no relevance whatsoever to actual scenario. Consequently, it may not be construed that the groupings followed in this book has ever been used or even remotely accepted by any of our Rishi.

Hence, the first segment is micro level of Time Reckoning or Kal Ganana that deals with such portion of Kal Maan or Time measure that is less than an ahoratra or 24 hours or a day. Modern smallest time unit accepted and adopted the world over is a second. In rare cases, this smallest time unit is measured through high precision clocks up to one hundredth part for sports like athletics, swimming events etc. Only in 1964, Cesium Atomic clocks were designed and manufactured to measure very small time units. Its second segment is termed as mega level of Time Reckoning or Kal Ganana that has been designed to include a component of Kal Maan or Time Unit that varies from ahoratra or a day to a year.

Micro Level of Time Reckoning or Kal Ganana

For clear understanding of Kal Maan or Time Unit at micro level, Rishi or scientists designed various schemes and terms to account for their properties in order to delineate different values lower than that of ahoratra or 24 hours or a day. Therefore, a few data sets have been selected from the huge pile of information available in order to delve into various characteristics of micro Kal Maan.

In order to begin the assessment of micro level time measure data sets, it is but obvious that we first assess what reference is available in Ved. Therefore, Vedic Rishi had assigned terms for this purpose that are given in the following Table 10.

Table 10: Micro Level of Kal Maan by Vedic Rishi

Sr.No.	Micro Kal or Time Units	Modern Time Units
1	1 Ahoratra = 30 Mahurat	24 hours or Day & Night
2	1 Mahurat = 15 Kshipra	48 minutes
3	1 Kshipra = 15 Atheri	3 minutes and 12 seconds
4	1 Atheri = 15 Idani	12.8 seconds
5	1 Idani = 15 Uchhawas	1.17^{th} of a second or 0.853 sec.
6	1Uchhawas = 15 Prashawas	17.578^{th} of a second or 0.0569 sec.
7	1 Prashwas = 15 Nimesh	263.67^{th} of a second or 0.0038 sec.
8	1 Nimesh	3955^{th} of a second or 0.000253 sec.

Thus, it is clear from the above data set that Vedic Rishi designed the lowest values only up to Nimesh level that represents 3955^{th} part of a second that works out to be 0.000253 second.

Rishi of Atharav Jyotish[17] propounded yet another set of terms to denote various levels of micro Kal Ganana. These terms are enumerated in Table 11.

Table 11: Micro Kal Maan or Time Units (Atharav Jyotish)

Sr.No.	Micro level of Kala Units	Modern Time Units
1	1 Ahoratra = 30 Mahurat	24 hours or a day
2	1 Mahurat = 30 Truti	48 minutes
3	1 Truti = 30 Kala	1 minute and 36 seconds
4	1 Kala = 30 Luv	3.2 seconds
5	1 Luv = 12 Nimesh	9.3rd of a second or 0.106667 sec.
6	**1 Nimesh**	112.5 **or 113th of a second or 0.008889 sec.**

Rishi of Atharav Jyotish also preferred Nimesh as the smallest Kal Maan or Time Unit but assigned a different value which works out to be 113th part of a second or 0.008889 second.

Rishi of Vishnu Puran has coined a different set of terms to depict their concept of micro level of Time Units or Kal Maan. The relevant shlok are given below:-

Kashtha panchdashakhyata nimesha munisattma
Kashthastrinshatkala trishuntkala mauhoorattiko vidhih
Taavatsankhyeerahoratram muhoortaiyarmaanusham smritam
Ahoratrani taavanti Masah pakshdvyatmakah[18]

The terms of above shlok are listed in the following Table 12.

Like previous Rishi, the term for the lowest value has been retained as Nimesh but its value has been elevated to 2.34th part of second or 0.426667 second.

Kautilya[19] delved into this fascinating aspect of Kal Ganana and came out with a hybrid terminology that imbibed a different set of values. His data is given in Table 13.

Table 12: Micro level of Kal Maan or Time Units (Vishnu Puran)

Sr.No.	Micro level Time Units	Modern Time Units
1	1 Ahoratra = 30 Mahurat	24 hours or a day
2	1 Mahurat = 2 Nadika	48 minutes
3	1 Nadika = 15 Kala	24 minutes
4	1 Kala = 30 Kashtha	1 minute and 36 seconds
5	1 Kashtha = 15 Nimesh	6.4 seconds
6	**1 Nimesh**	**2.34th of a second or 0.426667 second**

Table 13: Micro level of Kal Maan or Time Units (Kautilya's Artha Shastra)

Sr.No.	Micro level Time Units	Modern Time Units
1	1 Ahoratra = 15 Mahurat	24 hours or a day
2	1 Mahurat = 2 Nadika	1 hour and 36 minutes
3	1 Nadika = 40 Kala	48 minutes
4	1 Kala = 30 Kashtha	1 minute and 27 seconds
5	1 Kashtha = 5 Nimesh	2.9 seconds
6	1 Nimesh = 2 Luv	1.7th of a second or 0.58 sec.
7	1 Luv = 2 Truti	3.4th of a second or 0.29 sec
8	**1 Truti**	6.8 or **7th of a second** or 0.145 sec.

Kautilya coined a completely a different term to address the lowest value of a Time Measure that he called Truti which has been assigned 7th part of a second or 0.145 second.

Bhaskaracharya[20], notwithstanding, dealt the subject in a very subjective manner and described its nuances. Therefore, he adopted a different terminology in describing Micro level of Kal Ganana or Time Reckoning. He postulated very minute Kal Maan or time measures during analysis of this component. His data set is enumerated in Table 14.

Table 14: Micro Level of Kal Maan or Time Units of Bhaskaracharya

Sr.No.	Micro Levels or Time Units	Modern Time Units
1.	1 Ahoratra = 30 Mahurat	24 hours or a day
2.	1 Mahurat = 2 Ghati	48 minutes
3.	1 Ghati = 30 Kala	24 minutes
4.	1 Kala = 30 Kashtha	48 seconds
5.	1 Kashtha = 18 Nimesh	1.6 seconds
6.	1 Asu = 45 Nimesh	4 seconds
7.	1 Nimesh = 30 Tatpar	11.25^{th} of a second or 0.0889 second
8.	1 Tatpar = 100 Truti	337.5^{th} of a second or 0.00296 second
9.	1 Truti	$33,750^{th}$ of a second or 0.0000269 second

The perusal of Table 14 reveals that Bhaskaracharya was the first scientist who recorded data even lower than Nimesh level and found that Truti is the smallest time unit or measure of Micro level of Time Reckoning or Kal Ganana. He has defined it as time taken to needle across a lotus leaf. He further suggests Asu or Pran as a cognizable smallest unit which is equivalent to length of breath of a healthy man that was found to have been calculated to be 4 seconds.

At this stage, it is striking to record that an ahoratra or 24 hours or a day, consists of 21,600 Asu or Pran. This figure has very interesting connotations since one rotation of the Earth around its polar axis, takes place in 21,600 Asu. Moreover, there are 21,600 seconds in a circle or an ellipsoid. Also, he used yet another term Tatpar that has been defined as the time taken by a healthy sleeping man to open his eyes on awakening from sleep. It represents 100^{th} part of a Truti and almost 1000^{th} part of a Lagan or an ascendant.

Ved Vyas[21] was another Rishi who analyzed this problem in an absolutely different perspective. He did not hesitate to employ yet another set of hybrid terminology that is purported to be advance in nature. He adopted completely a different approach in order to analyze this subtle phenomenon. He carefully scrutinized the methodology of various predecessor scientists and found some missing links that might have emerged due to perhaps astronomical behavior of heavenly bodies. Therefore, Rishi Ved Vyas was able to reach perceptibly the lowermost micro levels in Kal Maan ever recorded by any human being.

The entire sequence of various terms used to describe micro level of Time Reckoning is listed in Table 15.

Rishi used a new term Parmanu for the lowest value of Kal Maan or Time Measure that was calculated to be $37,969^{th}$ part of a second or 0.000026337 second. Let it may be emphasized again that this value happens to be the lowest ever unit recorded for Kal Maan or Time Measure by any scientist pertaining to any civilization.

Table 15: Micro level of Time Units of Ved Vyas

Sr.No.	Micro level Kal Units	Modern Time Units
1	1 Ahoratra = 30 Mahurat	24 hours or a day
2	1 Mahurat = 2 Nadika	48 minutes
3	1 Nadika = 15 Laghu	24 minutes
4	1 Laghu = 15 Kashtha	1 minute 36 seconds
5	1 Kashtha = 5 Kshem	6.4 seconds
6	1 Kshem = 3 Nimesh	1.28 seconds
7	1 Nimesh = 3 Luv	2.34th of a second or 0.42667 sec.
8	1 Luv = 3 Vedh	7.03rd of a second or 0.14222 sec
9	1 Vedh = 100 Truti	2.109th of a second or 0.047407 sec
10	1 Truti = 3 Tresarenu	2109th of a second or 0.00047407 sec.
11	1Tresarenu = 3 Anu	6328th of a second or 0.00015802 sec
12	1Anu = 2 Parmanu	18984th of a second or 0.000052675 sec.
13	**1 Parmanu**	37968.75 or **37969th of a second** or 0.000026337 sec.

Lowest Value of Kal Maan or Time Measure

Enormous data concerning micro level of Time Reckoning or Kal Ganana exists but in above pages only sample of various epochs has been taken to record certain salient observations. The perusal of above Tables reveals that no ambiguity of any sort exists in these data sets. On the other hand, it exhibits merely a scientific thought that was prevalent as a result of voluminous research carried out by our Rishi. Arrangement of data sets in various Tables has been done in this fashion purposely by the author so that additional information could emerge on analysis.

The values of Kal Maan or Time Measure of Ahoratra or 24 hours or a day was adopted to be the same by all Rishi so that it can be safely taken as a base value for the purpose of further analysis of data sets. Vedic Rishi designed 7 time units within an ahoratra or 24 hours. However, it is interesting to record that the lowest value of the Time Unit is not uniform but varies from one scientist to another. The lowest value of Time Unit of Vedic Rishi is Nimesh that is 3955th part of a second or 0.000253 seconds whereas that of Bhaskaracharya is Truti

which works out to be 33,750th part of a second or 0.0000269 second. Moreover, the lowest ever value of time unit has been attributed to the one indicated by Rishi Ved Vyas, as postulated in Bhagvat Puran. He designed the term as Parmanu which is 37,969th part of a second or 0.000026337 second. It may be added that this is the lowest value of micro level of Kal Maan or time unit recorded by our Rishi or scientists. Thus, these Rishi of different times designed different terms to express dissimilar connotations for the lowest value of a second. Is it not mind- boggling?

Yet another set of analysis has been attempted by the author to get a clearer view amongst values of these time units. For this purpose, the following Table 16 has been generated that incorporates such data sets so that many ambiguities are clarified.

These data sets give an insight to the development of knowledge on this level of Time Units or Kal Maan. It also sets aside any misgivings that might arise about the usage of either of these terms in a different sense. Therefore, the perusal of data sets of Table 16 brings out very interesting results.

The term Truti is widely known amongst scientists/scholars who hereby mostly "believe" that it represents the smallest unit of Kal Maan. This perception is not based on any sound footings. It is admitted that Bhaskaracharya did attribute his lowest value to this term and that might have given scope for any sorts of ambiguity.

Therefore, this type of analysis was taken up by the author in order to clear any misgiving. Further, out of six Rishi of different span of time, only four scientists have utilized this term but none of them have attributed any common value of Kal Maan or Time Unit to it. Hence, the largest value allotted to Truti is 1 minute 36 seconds that was provided by Rishi of Atharav Jyotish, which is followed by 6.8th part of a second or

Table 16: Comparative Data on Micro level Time Units by Various Rishi

Value	Vedic Rishi	Atharav Jyotish	Vishnu Puran	Bhaskaracharya	Ved Vyas	Kautilya
Mahurat	48 minutes	48 minutes	48 minutes	48 minutes	48 minutes	1 hour 36 mts
Truti	-	1 mt and 36 sec.	-	33750th of a sec. or 0.000027 sec	2109th of a sec or 0.00047sec.	6.8th of a sec. or 0.145 sec.
Kala	-	3.2 sec.	I mt.36 sec.	48 sec.	-	1 mt. 27 sec.
Nimesh	3955th of a sec or 0.000253 sec.	113th of a sec or 0.0089 sec.	2.34th of a sec. or o.427 sec.	11.25th of a sec. or 0.0889 sec.	2.34th of a sec or 0.427 sec.	1.7th of a sec. or 0.58 sec.
Luv	-	9.3th of a sec or 0107 sec.	-	-	7.03th of a sec. or 0.1422 sec.	3.4th of a sec. or 0.29 sec.

Value	Vedic Rishi	Atharav Jyotish	Vishnu Puran	Bhaskaracharya	Ved Vyas	Kautilya
Kashtha	-	-	6.4 seconds	1.6 seconds	6.4 seconds	2.9 seconds
Nadika	-	-	24 minutes	-	24 minutes	48 minutes
Parmanu	-	-	-	-	37,969th of a sec or 0.000026337 sec.	-

0.145 second by Kautilya. However, Ved Vyas had assigned Truti the value of 2109th part of a second or 0.00047407 second. Finally, it was only Bhaskaracharya who postulated the penultimate lowest value to this term of the order of 33,750th part of a second or 0.0000269 second. Therefore, it is believed that aforesaid analysis would clear any sorts of doubts that might have persisted.

Mahurat is the term that finds itself addressed in all the above data sets pertaining to six Rishi. Nevertheless, it is interesting to notice that all five Rishi or scientists have adopted a value of 48 minutes except Kautilya who assigned it a value of 1 hour and 36 minutes.

Similarly, the term Nimesh also finds favour with all six Rishi. Its highest value of less than a second or 1.7th part of a second or 0.58 second has been assigned by Kautilya in his Arth Shastra. It is followed by a value of 2.34th of a second or 0.42667 second that was assigned by Rishi of Vishnu Puran and Veda Vyas. Bhaskaracharya allotted the value of 11.25th part of a second or 0.0889 second while Rishi of Atharav Jyotish assigned it a value of 113th part of a second or 0.008889 second. On the other hand, Vedic Rishi provided it with the lowest value of 3955th part of a second or 0.000253 second. Notwithstanding, it is quite evident from the above data set that even Vedic Rishi had gone as low as 3955th part of a second or 0.000253 second for undertaking various astronomical and/or astro-physical calculations.

Moreover, the term Kashtha also finds favour with 4 out of 6 Rishi and assigned values ranging from 6.4 seconds (Rishi of Vishnu Puran and Veda Vyas) to 2.9 seconds (Kautilya) and thereafter to 1.6 seconds (Bhaskaracharya).

On the Other hand, remaining two terms amongst the common ones, are Nadika and Luv that were coined by only three Rishi. The value of Nadika given by Rishi of Vishnu Puran and Ved

Vyas happened to be similar which works out to be 24 minutes whereas Kautilya had assigned 48 minutes to it.

Finally, Luv also finds favour with only three scientists namely Ved Vyas, Rishi of Atharav Jyotish and Kautilya. This term was used by these Rishi to indicate value of Kal Maan or Time Unit which is less than a second. Its highest value was assigned by Kautilya (3.4^{th} part of a second or 0.29 second) which is followed by Ved Vyas (7.03^{th} part of a second or 0.14222 second). Rishi of Atharav Jyotish attributed it the lowest value of 9.3th part of a second or 0.106667 second.

In the end, The above referred data sets clearly brings out appellations of micro level of Time Reckoning that varies from ahoratra or a day to as low as 0.000026337 second which can also be expressed as $37,969^{th}$ part of a second. Isn't it amazing?

Macro Level of Time Reckoning or Kal Ganana

Higher levels of Kal Maan or Time Units were also designed after conducting a thorough scientific research by our Rishi to account for perceptible time units that are experienced by mankind. Therefore, study of micro level time units is succeeded by Kal units at a macro level. These time units encompass calculations to delineate the limits of a day, week, *paksha* or fortnight, month, *ritu* or seasons, and a year.

These macro level time units are caused not by any event that can even remotely be attributed to any of the non – scientific reasons. In fact, three astronomical phenomena are responsible for contribution to generation of macro level Kal units. These activities are being pursued relentlessly and concomitantly from times in antiquity which are enumerated below:

- Rotation of Prithivi or the Earth around its polar axis from the west to the east.
- Revolution of the Earth around Surya or the Sun along its own ecliptic path.

- Revolution of Chandra or the Moon around the Earth along its orbit

Therefore, the above referred phenomena are the functions of *grah* or planets and *upgrah* or satellites of our Saur Mandal or solar system that are being discussed in this chapter.

A. Din Maan or Day Measure

It is interesting to note that a day is formed due to three above mentioned astronomical phenomena. Accordingly, different terminology exists for addressing days like Chandra or lunar day, nakshatra or constellation day, Saur or solar day and Savan day based on parameter that generates it. The intricacies concerning constitution of different types of days are discussed in the succeeding pages.

Tithi or Chandra or Lunar Day

Chandra or the Moon revolves along its orbit around Prithivi or the Earth in 27.3216615 days. This figure works out to be 27 days, 7 hours, 43 minutes and 11.6 seconds. Consequently, its daily motion varies from 11 degrees 47 minutes and 15 seconds to 15 degrees 15 minutes and 02 seconds wherein its mean value is 13 degrees 10 minutes and 35.0 seconds. It is quite evident that one lunar revolution along its orbit around the Earth, gives rise to one lunar month. Thus, a Chandra or lunar day is thirtieth part of a lunar month.

Rishi addressed a Chandra or lunar day into a Tithi and designed separate terms for each Tithi. A Tithi also demarcates an angular distance of 12 degrees of sidereal longitudes of Chandra or the Moon from Surya or the Sun.

Had relative motions of the Moon and the Sun remained unchanged in geo – centric model, the duration of all Tithi or lunar days would have been equal. Alas! It is not the scenario. The motion of Chandra and Surya is variable wherein Chandra sometimes moves faster whereas on other occasions, it acquires

a slower motion. Hence, duration of a Tithi or lunar day also keeps on varying from day to day. Our Rishi took a due cognizance of this phenomenon and observed that span of a Tithi varies from 19 hours and 59 minutes to 26 hours and 47 minutes. Nevertheless, mean value of duration of a Tithi has been calculated to be 23 hours, 37 minutes and 28.096 seconds. Since no Tithi or a lunar day will ever begin at mid night, thus, any Tithi operating at the time of sunrise is taken into cognizance and is deemed to have operated during the entire day. Nevertheless, span of each Tithi is precisely calculated and beginning as well as ending moments of each Tithi is given in any panchang or ephemeris.

In Table 17 which is self explanatory, nomenclature and domains various Tithi or lunar days are given.

Table 17: Nomenclature of Tithi or Lunar Days

Tithi	Name of Tithi	Angular Distance between the Chandra or the Moon and Surya or the Sun	
		Shukla Paksh or Bright	Krishna Paksh or Dark
1	Pratipada	0 deg. - 12 deg.	180 deg. - 168 deg.
2	Dviteeya	12 deg. - 24 deg.	168 deg. - 156 deg.
3	Triteeya	24 deg. - 36 deg.	156 deg. - 144 deg.
4	Chaturthi	36 deg. - 48 deg.	144 deg - 132 deg.
5	Panchami	48 deg. - 60 deg.	132 deg. - 120 deg.
6	Shashti	60 deg. - 72 deg.	120 deg. - 108 deg.
7	Saptami	72 deg. - 84 deg.	108 deg. - 96 deg.
8	Ashtami	84 deg. - 96 deg.	96 deg. - 84 deg.
9	Navami	96 deg. - 108 deg.	84 deg. - 72 deg.
10	Dashami	108 deg - 120 deg.	72 deg. - 60 deg
11	Ekadashi	120 deg. - 132 deg.	60 deg. - 48 deg.
12	Dvadashi	132 deg. - 144 deg.	48 deg. - 36 deg.
13	Triyodashi	144 deg. - 156 deg.	36 deg. - 24 deg.
14	Chaturdashi	156 deg. - 168 deg	24 deg - 12 deg.
15	Poornima	168 deg - 180 deg	-
30	Amavasya	-	12 deg - 0 deg.

Every Tithi is always accompanied by yet another component that is addressed with qualifying prefix of Shukla (bright) or Krishna (dark) Paksha or fortnight that will be discussed at a later stage.

A Tithi has further been divided into two equal parts called Karan. All Karan of various Tithi are given in Table 18.

Table 18: Karan of Tithi or Lunar days

Tithi	Tithi Name	Shukla Paksha or Bright Fortnight		Krishna Paksha or Dark Fortnight	
		1st Karan	2nd Karan	1st Karan	2nd Karan
1	Pratipada	Kinstughna	Bav	Balav	Kaulav
2	Dviteeya	Balav	Kaulava	Taitilya	Gara
3	Triteeya	Taitla	Gara	Vanija	Vishti
4	Chaturthi	Vanija	Vishti	Bav	Balav
5	Panchami	Bav	Balav	Kaulav	Taitilya
6	Shashti	Kaulav	Taitilya	Gara	Vanija
7	Saptami	Gara	Vanija	Vishti	Bav
8	Ashtami	Vishti	Bav	Balav	Kaulav
9	Navami	Balav	Kaulav	Taitilya	Gara
10	Dashmi	Taitla	Gara	Vanija	Vishti
11	Ekadashi	Vanija	Vishti	Bav	Balav
12	Dvadashi	Bav	Balav	Kaulav	Taitilya
13	Triyodashi	Kaulav	Taitilya	Gara	Vanija
14	Chaturdashi	Gara	Vanija	Vishti	Shakun
15	Poornima	Vishti	Bav	-	-
30	Amavasya	-	-	Chatushpad	Naga

Seven Karan or half of a Tithi or a lunar day namely Bav, Balav, Kaulav, Taitilya, Gara, Vanija and Vishti appear in a regular sequence. These are repeated eight times in a lunar month. Shakun Karan during later half of Chaturdashi or 14th lunar day of Krishna Paksha or dark fortnight, Chatushpad

Karan during first half of Amavasya or new moon day and Kinstughan Karan during first half of Pratipada or 1st lunar day of Shukla Paksha or bright fortnight occurs only once.

Nakshatra or Constellation Day

Since Prithivi or the Earth rotates around its own polar axis from the west to the east, one observes apparent movement of *grah* or planets and nakshatra or constellations that appear to move towards the west. Whenever, any place on this Earth gets aligned once again with the same nakshatra or constellation as a consequence of rotation of the Earth; it is termed as a nakshatra or constellation day. Each such day contains 21,600 Asu wherein each Asu is equivalent to 4 nakshatriya or constellation seconds. Thus, 24 such hours (21,600 Asu) constitutes a nakshatra day. The mean duration of Nakshatra Tithi or constellation day is 24 hours, 17 minutes and 9.317 seconds.

The time depicted in our clocks is not nakshatra time but it orientes itself by getting accelerated by 10 seconds per clock hour. It is striking to record that this time is being used these days by space scientists. Moreover, macro level Kal Maan or Time Units are also undertaken from nakshatra maan or constellation measure. 30 nakshatra or constellation days account for one month and 360 nakshatra days constitute one nakshatra year.

Savan Day

It takes almost 24 hours from sunrise to the next sunrise to complete one civil day as a result of rotation of the Earth. For almost 12 hours, one portion of the Earth faces the Sun whereby day light is experienced there while the other half of the Earth is exposed to darkness where night is felt. Therefore, sunshine exposed portion is called *ahoh* or a day of the Earth that faces the east whereas the darker areas where sunshine is unable to reach, is known as *ratri* or night. Hence, a day and a night comprising 24 hours are called Ahoratra which is also known as Savan day.

It was observed by our Rishi that during the course of rotation of the Earth around its polar axis, Prithivi shifts westwards along its orbit at the rate of 59 Kala, 8 Vikala and 10 Prativikala. Therefore, some delay is experienced next day for the same spot to reach in alignment with the Sun. This delay is almost equal to 59 Asu. In other words, Savan day is longer by 59 Asu than nakshatra day. In other words, nakshatra or constellation day is shorter by 3.93 minutes or 3 minutes and 56 seconds from Savan day. Consequently, Savan day consists of 21,659 Asu or 24.0656 hours or 24 hours, 03 minutes and 56 seconds.

Saur or Solar Day

As mentioned earlier, Prithivi or the Earth revolves around the Sun along its ecliptic at the rate of 1, 00,000 km per hour or 29.79 km per second. Its one revolution around the Sun is completed in 365.25 Ahoratra or Saur days.

A Saur day is approximately 165 Asu or 11 minutes longer than a Savan day. Therefore, a mean solar day is 24 hours, 03 minutes and 56.55537 seconds of mean sidereal time.

Kshya or Decremented Lunar Day

It is a well known fact that a Tithi gets kshya or decremented during course of time and is related to a Savan day. The duration of a Tithi consists of 21,320 Asu whereas Savan day is equivalent to 21,659 Asu. In other words, one Savan day encompasses one Tithi plus 339 Asu. If one Savan Maan (21659 Asu) is divided by 339, quotient is 63. Therefore, it is implied that after lapse of 63 Tithi or lunar days, a Tithi exceeds Savan Maan by a day. Consequently, the count of one Tithi is dispensed with in order to integrate Tithi with Savan day. Senso stricto, it is not the Tithi that gets kshya or decrements but its count is made to lose one day. Therefore, Kshya Tithi or decremented lunar day has no relation with the

sunrise. In this manner, Tithi and Savan days are integrated with each other.

B. Saptah Maan or Week Measure

Seven days constitute one Saptah or a week. During Vedic times, seven days of a week were called Vasar but later these were known as Var. The nomenclature of seven var or days is Ravi (Sun) Var or day, Som (Moon or Mon) Var or day, Mangal (Mars) Var or Tuesday, Budh (Mercury) Var or Wednesday, Brihaspati (Jupiter) Var or Thursday, Shukra (Venus) Var or Friday and Shani (Saturn) Var or Saturday. Names and sequence of week days has a specific purpose since it is followed all over the world. It is quite clear that this sequence and nomenclature of week days has originated from Bharat or India as it has justifiably been elucidated by Bhaskaracharya.

As per ancient Bhartiya or Indian thought, ecliptic of the Earth is overlain by that of the Moon that in turn is followed by the Mercury, the Venus, the Sun, the Mars, the Jupiter and the Saturn respectively in a geo-centric model.

These ecliptics have also been referred in Yajur Ved:-

Saptasyasana paridhayah[22]

Paridhi or ecliptics pertaining to 7 *lok* or "worlds" lie over that of the Earth. These seven *lok* are termed as *Bhu, Bhuvaha, Swaha, Maha, Janaha, Tapaha* and *Satyam* respectively. Similar principles are observed in deciphering the names of a week by Rishi of Surya Siddhant.

However, two schools of thought exist pertaining to time of beginning of a day or a week. Rishi of first school believe that Srishti or the Cosmos was created at midnight. Therefore, beginning of a week is reckoned from midnight while that of a day is taken from sunrise. The concept of *Dev* or divine day or

perception of Uttarayan and Dakshinayan (to be discussed in subsequent pages of this book) also corroborates the principle of day and week beginning from midnight. Same doctrine explains the reason for accepting Shukla and Krishna Paksha as day and night respectively of Pittar or ancestors. On the other hand, some Rishi opined in creation of Srishti or the Cosmos at the time of sunrise. Therefore, they accept beginning time of a day as well as week from the sunrise. It may be added that both the above principles have been accepted for use in daily life. In modern days, a date changes on midnight whereas a Tithi or lunar day is known by the one existing at the time of the sunrise.

Nomenclature of Days in a Saptah or a Week

Since Srishti or the Cosmos was created at the time of the sunrise and Surya or the Sun happens to be ruler of our solar system, the first day of Saptah or a Week has been allotted to the Sun i.e. Ravivar or Sunday. As a matter of fact, every hour of a day was considered to be ruled by a *grah* or a planet in such a manner, which is followed in the geocentric model pertaining to ecliptic of planets of our solar system described earlier. Accordingly, the name of a day is attributed to the ruler of first hour or Hora with which it begins. For example, first hour of 1st day of a week begins with Surya or the Sun. Consequently, it is termed as Ravivar or Sunday (based on Ravi or Surya or the Sun). Thereafter, after a lapse of 23 hours, the first hour of 2nd day belongs to Som or Chandra or the Moon. Hence, second day of the week is known as Somvar or Monday. In this way, same sequence will continue for deciphering the names of remaining days of the week.

Jha (1985)[23] compiled various hora for addressing names of days in a week. Table 19 catalogues the data that makes amply clear the nomenclature of a day during the week.

Hence, the perusal of above Table shows that it is only hora and its lord that plays the role in addressing the day of a week. The sequence of pertaining to nomenclature of a week day has now been universally accepted and followed all over the world.

Table 19: Nomenclature of Saptah Maan or Week Days

Ruler of Day/ Hora	Name of Week						
	Ravivar (Sunday)	Somvar (Monday)	Mangalvar (Tuesady)	Budhvar (Wednesday)	Guruvar (Thursday)	Shukravar (Friday)	Shanivar (Saturday)
1	***SUN***	Moon	Mars	Mercury	Jupiter	Venus	Saturn
2	Venus	Saturn	**SUN**	Moon	Mars	Mercury	Jupiter
3	Mercury	Jupiter	Venus	Saturn	**SUN**	Moon	Mars
4	Moon	Mars	Mercury	Jupiter	Venus	Saturn	**SUN**
5	Saturn	**SUN**	Moon	Mars	Mercury	Jupiter	Venus
6	Jupiter	Venus	Saturn	**SUN**	Moon	Mars	Mercury
7	Mars	Mercury	Jupiter	Venus	Saturn	**SUN**	Moon
8	**SUN**	Moon	Mars	Mercury	Jupiter	Venus	Saturn
9	Venus	Saturn	**SUN**	Moon	Mars	Mercury	Jupiter
10	Mercury	Jupiter	Venus	Saturn	**SUN**	Moon	Mars
11	Moon	Mars	Mercury	Jupiter	Venus	Saturn	**SUN**

Ruler of Day/ Hora	Name of Week						
	Ravivar (Sunday)	Somvar (Monday)	Mangalvar (Tuesady)	Budhvar (Wednesday)	Guruvar (Thursday)	Shukravar (Friday)	Shanivar (Saturday)
12	Saturn	SUN	Moon	Mars	Mercury	Jupiter	Venus
13	Jupiter	Venus	Saturn	SUN	Moon	Mars	Mercury
14	Mars	Mercury	Jupiter	Venus	Saturn	SUN	Moon
15	SUN	Moon	Mars	Mercury	Jupiter	Venus	Saturn
16	Venus	Saturn	SUN	Moon	Mars	Mercury	Jupiter
17	Mercury	Jupiter	Venus	Saturn	SUN	Moon	Mars
18	Moon	Mars	Mercury	Jupiter	Venus	Saturn	SUN
19	Saturn	SUN	Moon	Mars	Mercury	Jupiter	Venus
20	Jupiter	Venus	Saturn	SUN	Moon	Mars	Mercury
21	Mars	Mercury	Jupiter	Venus	Saturn	SUN	Moon
22	Sun	Moon	Mars	Mercury	Jupiter	Venus	Saturn
23	Venus	Saturn	SUN	Moon	Mars	Mercury	Jupiter
24	Mercury	Jupiter	Venus	Saturn	SUN	Moon	Mars

C. Paksha Maan or Fortnight Measure

A Paksha Maan or a fortnight measure is very significant while completing an address of a Tithi. Since every Tithi is repeated twice in a month except Poornima or full moon day and Amavasya or new moon day, it is imperative that it is qualified properly by an appropriate designation. For example, Panchami or 5^{th} lunar day alone may create confusion because it will cover two zones of angular distance between Chandra or the Moon and Surya or the Sun comprising 48^0 to 60^0 and 132^0 to 120^0 as noticed in Table 17. Therefore, it becomes essential to indicate the status of the fortnight in which a Tithi occurs. Only this process will clearly,address whether the first zone of above mentioned example is being referred or the second one.

When Chandra or the Moon lies in conjunction with Surya or the Sun, the day of this conjunction, is called Amavasya or new moon day. Subsequent to this conjunction, Chandra travels at a faster rate than Surya or the Sun (in geo – centric model). This process continues for next 15 days till it gets posited 180 degrees apart from the Sun. At this stage, Chandra or the Moon lies in opposition to the Sun. Accordingly, waxing of the Moon takes place with the passage of every Tithi or lunar day. If Chandra or the Moon acquires one digit of brightness on 1^{st} Tithi or lunar day, it keeps on increasing on subsequent days. Therefore, the process of augmentation in the size and shape of the disc of the Moon continues with the passage of each day till the full disc of the Moon is visible. This particular day of full Moon is called Poornima or Poornamashi Hence, Shukla Paksha or bright fortnight is the one in which *kala* of Chandra or degree of brightness of the Moon increases every day. In other words, a fortnight commencing from Amavasya or new moon day to Poornima or full moon day that consists of nearly 15 days is known as Shukla Paksha or Bright Fortnight.

Thereafter, the distance between the Moon and the Sun starts reducing with passage of Tithi or lunar day from Poornima and dark fortnight of the month commences. This process also

continues for next 15 days and finally Chandra or the Moon gets posited in conjunction with the Sun. As a consequence of this phenomenon, Chandra starts waning and bright part of the disc of the Moon starts shedding one digit with passage of every Tithi. This activity continues for about 15 days when Chandra or the Moon possesses no brightness at all and the Moon becomes invisible on Amavasya or new moon day. Therefore, fortnight commencing from Poornima or full moon day to Amavasya or new moon day is termed as Krishna Paksha or dark fortnight of the month. Therefore, in above mentioned example, the first zone of Panchami (48^{o} to 60^{o}) pertains to Shukla Paksha or bright fortnight whereas the second one (13^{20} to 120^{o}) refers to Krishna Paksha or dark fortnight.

One can easily discern whether Shukla or bright fortnight or Krishna Paksha or dark fortnight is in progress on a given day. One has to view the evening sky for this purpose. If Chandra or the Moon is visible at the time of dusk, Shukla Paksha or bright fortnight is operating. On the contrary, non-visibility of the Moon at dusk time is indicative of the existence of Krishna Paksha or dark fortnight. During this Paksha, the Moon rises at a later period in the night.

This discussion on Paksha is essential in order to clearly understand nomenclature of Tithi or lunar days otherwise ambiguity could have arisen. Hence, it is logical to conclude that Tithi or lunar day is intrinsically related to either Shukla or Krishna Paksha or bright or dark fortnights.

D. Mas Maan or Month Measure

Mas Maan or Month measure is still higher time unit than a week or a Paksha or fortnight. This time unit comes into existence due to operation of two processes.

Chandra Mas or Lunar Month

A richa or verse from Rig Ved clearly narrates that Chandra or the Moon is responsible for creating a Mas or a month:-

Aruno Mas krid vrikah[24]

Yask in his commentary on above richa, states that Chandra or the Moon is the maker of the months and half months. As a matter of fact, term Mas or month has been derived from Chandra Mas. Actually the meaning of Mas is a measurement since Chandra Mas measures nakshatra or constellations in the sky. This reference amply makes it clear that months are generated owing to revolution of Chandra or the Moon along its orbit around Prithivi or the Earth. From the discussion of Shukla and Krishna Paksha in the previous pages, it is explicit that Poornima or full moon day and Amavasya or new moon day are two significant days in Chandra Mas or lunar month.

In Uttar Bharat or northern India, a Chandra Mas or lunar month is calculated from Poornima or full moon day to next Poornima. Thus, a Chandra Mas begins with Krishna Paksha or dark fortnight that is followed by Shukla Paksha and ends with next Poornima or Poornima or a full moon day. However, in the entire ancient Bhartiya or Indian literature and Dakshin Bhartiya or South Indian treatises, domain of a lunar month extends from Amavasya or new moon day to next one. This school of thought is in consonance with the observation that Srishti or the Cosmos was created in Shukla Paksha. It is interesting to note that both the views are available in Ved.

In Uttar Bharat or northern India, a samvatsar or a year begins on Chaitra or 1st lunar month, Shukla Paksha or bright fortnight and Pratipada 1st lunar day. Owing to this difference, Krishna Paksha of every month is included in succeeding month by Uttar Bhartiya or north Indians whereas Dakshin Bhartiya or south Indians include it in preceding month. For example, Krishna Janma Ashtami or birth day of Bhagvan Krishna is known as Ashtami or 8th lunar day of Krishna Paksha or dark

fortnight of Bhadrapad or 6th lunar month whereas in South India, it is called Shravan or 5th lunar month, Krishna Paksha Ashtami. It is just a variation in expression otherwise the event is celebrated on the same day.

A Chandra Mas or a lunar month comprises 30 Tithi as shown in the Table 17. It is a tradition that Poornima is represented by a digit 15 whereas Amavasya is shown by a digit 30. The vital statistics of a lunar month suggests that it possesses 29.530589 days i.e. from Amavasya to new moon day. It works out to be 29 days, 12 hours, 44 minutes and 2.9 seconds.

Nomenclature of Chandra Mas or Lunar Month

It has already been mentioned that Chandra or the Moon crosses one nakshatra or constellation every day during the course of its revolution on its orbit around Prithivi or the Earth. Therefore, names of Chandra Mas are designed with integration of nakshatra or constellation with Tithi or lunar day. Accordingly, whenever Chandra or the Moon transits say Chitra nakshatra or α Virginis or Spica constellation on Poornima or full moon day, the month in which this phenomenon occurs is termed as Chaitra or 1st lunar month. Similarly, Vishakha nakshatra or α Libra constellation falls on Poornima of Vaishakh Mas or 2nd lunar month. Occasionally, there could be instances when the aforesaid scenario does not take place and a nakshatra or constellation may suffer a slippage into the next one.

However, Jha (1985)[25] has quoted the following shlok in order to explain some observed variations in the aforesaid phenomenon.

Dvay Dvay Chitraditaranam paripoornayndusangme
Masiaschaitaodyogyayaha panchadridashaMastrikayah

Subsequent two nakshatra or constellations beginning from Chitra or α Virginis or Spica, fall on Poornima of months of Chaitra etc. However, Poornima of fifth or Shravan, seventh or

Ashwin and tenth or Poush Mas or lunar months fall in subsequent three nakshatra or constellations.

Table 20 incorporates all relevant information including astronomical nomenclature of all nakshatra or constellations concerning Chandra Mas or lunar months.

Saur Mas or Solar Month

The Earth covers 30 degrees of ecliptic during the course of its revolution in a month because the ecliptic has been divided into 360 degrees or 12 Rashi or signs. This duration of a month is known as Saur Mas or Solar month. Rishi of Rig Ved makes it amply clear in the following richa or verse:-

Dvadasha pradhyashchkramayanka[26]

A solar year consists of 12 spokes of a wheel wherein each spoke is equivalent to a month.

Saur Mas or Solar Month varies from 29 to 32 days but its mean duration is 30 days, 10 hours, 31 minutes and 2.8 seconds. In geo-centric model, Surya or the Sun was posited at an initial point of Ashwini nakshatra or β Arietis constellation in Mesh rashi or Aries sign at the beginning of Srishti or the Cosmos. Therefore, Saur Mas begins from the transit of Surya or the Sun in Ashwini nakshatra in Mesh rashi. In other words, a year is completed after passage of 12 transits beginning from Mesh rashi. Therefore, solar months are termed after a rashi it happens to traverse such as Mesh, Rishabh, Mithun or Aries, Taurus, Gemini etc. Simultaneously, these months are also known after nomenclature of Chandra Mas or lunar months by integrating both these parameters. During Poornima, Surya or the Sun is posited 180 degrees apart from Chandra rashi or nakshatra. For example, whenever Surya or the Sun is in Ashwini nakshatra in Mesh Rashi, Chandra or the Moon gets parked in Chitra nakshatra in Tula rashi. Therefore, Mesh solar month is also called Chaitra or 1st Saur Mas or solar month.

Table 20: Chandra Mas or Lunar Months

Sr.No.	Chandra Mas	Nakshatra or Constellation Names on Poornima		Vedic Names	Ritu or Seasons	
		Nakshatra on Poornima	Constellation on Full Moon Day		Ritu	Season
1	Chaitra	Chitra	α Virginis	Madhu	Vasant	Spring
2	Vaishakh	Vishakha	α Libra	Madhava	Vasant	Spring
3	Jyeshth	Jyeshtha	α Scorpii	Shukra	Greeshma	Summer
4	Ashadh	Poorvashadh	σ Sagittarii	Shuchi	Greeshma	Summer
5	Shravan	Shravan	α Aquilae	Nabha	Varsha	Rains
6	Bhadrapad	Poorvabhadrapad	α Pegasi	Nabhasya	Varsha	Rains
7	Ashwin	Ashwini	β Arietis	Eesha	Sharat	Autumn
8	Kartik	Krittika	η Tauri	Oorja	Sharat	Autumn
9	Margsheersh	Mrigshira	λ Orionis	Saha	Haimant	Acute Winter

Sr.No.	Chandra Mas	Nakshatra or Constellation Names on Poornima		Vedic Names	Ritu or Seasons	
		Nakshatra on Poornima	Constellation on Full Moon Day		Ritu	Season
10	Poush	Pushya	δ Cancri	Sahasya	Haimant	Acute Winter
11	Magh	Magha	α Leonis	Tapa	Shishir	Winter
12	Phalgun	Poorvaphalguni	δ Leonis	Tapasya	Shishir	Winter

Jha (1985)[27] has given duration of each solar month in each rashi or sign that is recorded in Table 21.

Table 21: Duration of Saur Mas or Solar Month in each Rashi or Sign

Rashi	Duration			
	Day	Hour /**Ghati**	Minute /**Pal**	Second
Mesh	30	22 or **57**	50 or **06**	12
Rishabh	31	10 or **25**	18 or **46**	24
Mithun	31	15 or **38**	18 or **17**	48
Karak	31	10 or **27**	59 or **56**	24
Simha	31	0	16 or **41**	24
Kanya	30	10 or **25**	19 or **49**	36
Tula	29	21 or **52**	5 or **43**	12
Vrishchik	29	11 or **28**	24 or **32**	48
Dhanu	29	3 or **8**	24 or **31**	48
Makar	29	10 or **27**	50 or **6**	24
Kumbh	29	20 or **50**	11 or **28**	12
Meen	30	9 or **22**	2 or **36**	24
Duration	**Day**	**Ghati**	**Pal**	
2.5 Ghati = 1 hour 2.5 Pal = 1 minute				

Adhik Mas or Intercalary Month

It is noticeable from above discussion that Chandra Mas or Lunar month is also integrated with Saur Mas or Solar month. As indicated earlier, duration of a Chandra Mas is 29 ahoratra, 31 Ghati, 50 Pal and 7.5 Vipal corresponding to 29 days, 12 hours, 44 minutes and 2.9 seconds. Similarly, value of Saur Mas or solar month is 30 ahoratra, 26 Ghati, 17 Pal and 37 Vipal corresponding to 30 days, 10 hours, 30 minutes and 16.4 seconds. Therefore, the difference between the two distinct parameters works out to be 54 Ghati, 27 Pal and 29.5 Vipal corresponding to 21 hours, 46 minutes and 13.5 seconds. In other words, one Saur Mas or solar month includes one Chandra Mas or lunar month plus 21 hours, 46 minutes and 13.5 seconds. Consequently, this difference gets cumulated into one month after a lapse of 32.5 Saur Mas or solar months. Therefore, Chandra Mas acquires one additional month vis-à-vis Saur Mas after a lapse of 32.5 Saur Mas. This additional lunar month is called Adhik Mas or Intercalary month. It is always counted from Shukla Paksha or bright fortnight. It is interesting to observe that there is no Surya Sankranti or solar transit in Adhik Mas or intercalary month. Therefore, prefix adhik or additional is appended to the preceding Chandra Mas or lunar month.

Whenever, Saur Mas or solar month will possess a larger domain than its mean value, possibility of Adhik Mas or intercalary month exists. However, it has been observed that solar months starting from Tula to Kumbh (Libra to Aquarius) are shorter than its mean value. Hence, possibility of occurrence of Adhik Mas or intercalary month during above mentioned five months does not exit at all. Therefore, this phenomenon is restricted to Surya Sankranti or solar transit in rashi or signs from Mesh or Aries to Kanya or Virgo only.

Kshya Mas or Decremented Month

In Saur Mas or solar months between Tula and Kumbh months, a situation could emerge where it happens to become shorter in

duration than even Chandra Mas or a lunar month. In that scenario, two Saur Sankranti or solar transits will take place within a lunar month between Amavasya and new moon day. In other words, one Surya Sankranti or solar transit occurs after Amavasya whereas the second one materializes just before next one. Hence, two Saur Mas or solar months are required to be reckoned within a Chandra Mas or lunar month because it is Surya Mas that controls Chandra Mas. Therefore, one Chandra Mas or lunar month has to be counted twice wherein one month will get kshya or decremented and one will be forced to split one month to 60 Tithi or lunar days. This situation is called Kshya Mas or decremented month.

A Kshya Mas occurs after a lapse of 19 years from the year of its previous occurrence. Its subsequent recurrence will take place after the lapse of 141 years. Thereafter, this sequence will be repeated as described above. Thus, in Samvatsar 2039 or 1982 A.D., Kshya Mas or decremented month had been experienced after 19 years of its previous event (or Samvatsar 2020 corresponding to 1963 A.D.). Now, Kshya Mas or decremented month will be experienced again after the passage of 141 years from the year of its previous occurrence and this event will fall in Samvatsar 2180 corresponding to 2123 A.D.

It is fascinating to record whenever Kshya Mas or decremented month takes place, two Adhik Mas or intercalary months occur one after the other within a single year. Therefore, second Adhik Mas is included as per normal calculations whereas the first one is inserted due to occurrence of Kshya Mas based on above mentioned calculations. Consequently, Savan Maan gets merged with Saur Maan and the same fate awaits nakshatra or constellation, Chandra or the lunar, and Brihaspati or Jupiter Maan or units. Hence, Saur Maan or solar measure is fixed which is extensively used in mega level of Kal Ganana or Time Reckoning.

E. Ritu or Seasons

Ritu or seasons are related to Saur Maan or solar measure and six Ritu or seasons are expected in twelve rashi or signs transited by the Sun in a geo - centric model. During earlier days, Vasant Ritu or spring season was attributed to Mesh and Rishabh Mas or Aries and Taurus months, Greeshma Ritu or summer season to Mithun and Karak Mas or Gemini and Cancer months, Varsha Ritu or rainy season to Simha and Kanya Mas or Leo and Virgo months, Sharad Ritu or autumn season to Tula and Vrishchik Mas or Libra or Scorpio months, Haimant Ritu or winter season to Dhanu and Makar Mas or Sagittarius and Capricorn months and Shishir Ritu or acute winter season to Kumbh and Meen Mas or Aquarius and Pisces months as enumerated in the Table 20 given above.

Nonetheless, it is the tropical values that contribute to the above mentioned seasons which have now suffered some drastic variations. Hence, these days the scenario has changed accordingly. In fact, it is observed that occurrence of these Ritu or seasons have proceeded by a month. In geo - centric model, when Surya or the Sun is parked in Meen and Mesh rashi or Pisces and Aries signs, Vasant Ritu or spring season prevails. Similarly, the placement of the Sun in Rishabh and Mithun rashi or Taurus and Gemini signs, accounts for Greeshma Ritu or summer season. In this way, the location of Surya in other rashi or signs gives rise to remaining seasons.

F. Uttarayan and Dakshinayan

The term tropic of cancer or Karak Rekha is defined as parallel of latitude that is found at 23.5 degrees in northern hemisphere. Similarly, parallel of latitude of same value in the southern hemisphere is called tropic of Capricorn or Makar Rekha. These are two corresponding circles of 23.5 degrees in northern as well as southern hemisphere on celestial sphere where Surya or the Sun "appears" to return after reaching the greatest Kranti or declination in a geo – centric model. Appraisal of a few additional terms is also desirable at this stage. Our Rishi termed

0 degree parallel or the equator as Meru. Northern hemisphere was known as Sumeru while southern hemisphere was called Kumeru.

On or about 21st March Vasant Sampat or vernal equinox, the Sun rises in due east, ascends to its zenith point and descends to set in the west that is the apparent path of the Sun lying over the equator or Bhumadhya Rekha or Meru. On the following day, the Sun rises in the east again, ascends to its zenith and finally sets in the west but its apparent path does not lie exactly over the equator but shifts slightly towards north of the equator. This distance between Meru or the equator and the solar apparent path, is termed as Kranti or declination. Moreover, it is known as northern declination if the apparent solar path lies towards north of the equator or southern declination, if it is posited in the southern hemisphere. Declination is measured in degrees and minutes of an arc.

Had the axis of the Earth been normal to the equator, there would have not been any declination at all. On the contrary, it is tilted 23.5 degrees from the normal towards the equator. Whenever, Prithivi or the Earth starts shifting towards the north during the course of its revolution around the Sun along its ecliptic, Surya or the Sun "appears" to move towards the south. On the other hand, the Sun "appears" to move northwards whenever the Earth shifts towards the south. Hence, the apparent movement of Surya or the Sun towards the north is called Uttarayan whereas its southern movement is known as Dakshinayan.

From sayan or tropical Mesh or Aries sankranti or solar transit, on or around 21st March, Surya or the Sun lies over Bhumadhya Rekha or the equator where day and night are equal and is known as Vasant Sampat or vernal equinox. From this day onwards, the apparent path of the Sun shifts northwards with the passage of every day till about 21st June, it reaches its maximum limit of the northern declination. Concomitantly, the

duration of a day starts increasing in Sumeru or the northern hemisphere. Moreover, it starts reducing correspondingly in Kumeru or the southern hemisphere. Therefore, this day is the longest one in the northern hemisphere and the shortest one in Kumeru or the southern hemisphere. Uttar Kranti or northern declination of Surya or the Sun is 12 degrees after the lapse of Sayan Mesh rashi or tropical Aries sign; 20 degrees at the end of sayan Rishabh rashi or tropical Taurus sign and 23 degrees 30 minutes at the end of Sayan Mithun rashi or Gemini sign. Expressing it in a different manner, the maximum northern declination of the Sun occurs at the beginning of Sayan Karak rashi or tropical Cancer sign. Therefore, Karak Sankranti or Cancer transit is the northernmost limit of the apparent movement of the Sun which in fact, is the southernmost limit of the shift of the Earth. Moreover, the rays of the Sun fall perpendicularly on this parallel of latitude which is 23.5 degrees north on this very day. Hence, this latitude is called Karak Rekha or Tropic of Cancer. As described earlier, this scenario is observed on 21st June which is known as summer solstice.

Similarly, with the passage of time from 21st June onwards, the northern declination of Surya or the Sun begins to reduce day by day till it attains its original position. Its original position signifies that the Sun rises from the east, and passes over the equator and sets in the west which is attained on 23rd September. It is known as Sharat Sampat or autumnal equinox. Concomitantly, duration of a day starts decreasing from its longest one on 21st June in northern hemisphere till it gets equal in Dina Maan or day and night duration on 0 degree declination i.e. 23rd September. Consequently, the southern declination of the Surya or the Sun is posited 20 degrees in Sayan Simha sankranti or tropical Leo transit, 12 degrees in Sayan Kanya sankranti or tropical Virgo transit and 0 degree in Sayan Tula sankranti or tropical Libra transit.

After 23rd September, the "apparent path" of the Sun is not

posited over the equator but it gets shifted slightly towards its southerly direction. As a result of this phenomenon, southern declination of the Sun starts increasing with the passage of time every day. Thus, it lies at 12 degrees on Sayan Vrishchik sankranti or tropical Scorpio transit, 20 degrees on Sayan Dhanu sankranti or tropical Sagittarius transit and 23.5 degrees on Sayan Makar sankranti or tropical Capricorn transit. Therefore, the maximum southern declination of the Sun takes place at 23.5 degrees parallel of latitude on 22nd December which is also known as winter solstice. On this day, the rays of the Sun fall perpendicularly on this latitude which is also known as Makar Rekha or tropic of Capricorn. Duration of the day is the longest in the southern hemisphere whereas night in the northern hemisphere acquires the longest duration on this day. After having reached the maximum southern declination of the Sun on or around 22nd December, it starts reducing once again day by day wherein days start getting shorter in duration in the southern hemisphere. In other words, it rises and sets with lesser solar declination since the Sun is apparently shifting its path northwards. This phase is known as Uttarayan. Hence, the Sun is parked 20 degrees on Sayan Kumbh sankranti or tropical Aquarius transit during the course of southern declination and 12 degrees on Sayan Meen sankranti or tropical Pisces transit. During this period, duration of day starts increasing in the northern hemisphere whereas in the southern hemisphere, simultaneously it starts reducing. As a consequence of this phenomenon, day and night become equal on Sayan Mesh sankranti or tropical Aries transit wherein the "apparent" path of the Sun lies over the equator i.e. vernal or spring equinox or 21st March.

Hence, the Sun remains in Uttar Gole or northern hemisphere mode for six months beginning from Sayan Mesh sankranti. On the other hand, it remains in dakshin Gole for six months commencing from Sayan Tula sankranti or tropical Libra transit. Therefore, the Sun remains in *Uttarayan* for six months commencing from *Sayan Makar Sankranti* or tropical

Capricorn transit while it is parked in Dakshinayan from *Sayan Karak Sankranti* or tropical Cancer transit.

The degree of ecliptic where there is no declination of the Sun is called as Vasant Sampat or vernal equinox and Sharat Sampat or autumnal equinox that fall on 21st March and 23rd September respectively. In different words, it can be explained that these are two sensitive points on which the Sun crosses the equator during the course of the shift of the Earth wherein duration of day and night is equal. It is very pertinent to record at this stage that these equinox points are not fixed but these shift backwards. These equinoctial points preceede at the rate of 50.25 seconds of an arc per annum that works out to be 1 degree in almost 72 years. In other words, the equinoctial points that exited 72 years ago are not the one those are present today. These have shifted 1 degree backwards or preceeded by a degree. This phenomenon is called precession of equinoxes.

It is not the end of complexity but rotation of Prithivi or the Earth around its polar axis causes yet another peculiarity. It very closely resembles oscillation of a spinning top. This oscillation of the axis of the Earth imparts a wavy motion at the pole of the equator around the pole of its ecliptic. This phenomenon is known as nutation. Therefore, nutation in obliquity was computed to be + 8.38 seconds on 1st January 2006 A.D. Also, the true values of obliquity of the ecliptic on the above mentioned date was calculated to be 23 degrees 26 minutes and its mean value on the above date is 23 degrees 26 minutes and 18.64 seconds. Hence, precession of equinoxes and nutation are responsible for causing two equinoctial points to preceede continuously.

Shift in Tropics of Cancer and Capricorn and Variation in Sankranti

It has already been stated that equinoctial points preceede at the rate of one degree in nearly 72 years due to twin phenomena of precession of equinoxes and nutation. At the beginning of the

creation of Srishti or the Cosmos, Vasant Sampat or vernal equinox was in Ashwini nakshatra or β Arietis constellation in Mesh rashi or Aries sign. These points are invariably preceeding backwards and return to Ashwini nakshatra after a lapse of 25,920 or nearly 26,000 years. At present, Vasant Sampat or vernal equinox has shifted backwards or preceeded by 23 degrees, 56 minutes and 25 seconds on 1St January 2006 A.D. from Ashwini nakshatra (and its mean value on this day is calculated to be 23 degrees, 56 minutes and 27.17 seconds.). Now, Vasant Sampat or vernal equinox falls in Uttar Bhadrapad nakshatra or γ Pegasi constellation and not in Ashwini nakshatra or β Arietis constellation as was the scenario at the time of creation of the Cosmos

Similarly, Sharat Sampat or autumnal equinox does not fall in Chitra nakshatra or α Virginis constellation as was the situation but it is now parked in Uttar Phalguni nakshatra or β Leonis constellation. Consequently, Uttarayan and Dakshinayan that were once posited in the Surya Sankranti or solar transit of Sayan Makar rashi or tropical Capricorn sign and Sayan Karak rashi or tropical Cancer sign respectively; now takes place in Sayan Dhanu rashi or tropical Sagittarius sign and Sayan Mithun rashi or tropical Gemini sign respectively due to precession of equinoxes and nutation. Therefore, Dhanu rashi or Sagittarius sign represents 20 degree south and Mithun rashi or Gemini sign indicate 20 degrees north in nirayani ganana or sidereal reckoning. Consequently, Makar rekha or Capricorn sign and Karak rashi or Cancer sign will enhance by 3.5 degrees in the south and the north respectively as Makar rashi having been replaced by Dhanu while Karak rashi by Mithun in nirayani ganana or sidereal reckoning. This shift takes place in 2160 years.

G. Varsh Maan or Year Measure

Prithivi or the Earth revolves along its 966 million or 96, 60, 00,000 km long ecliptic around the Sun in 365.25 days. In other words, one revolution of the Earth accounts for passage of one

year. Thus, this year is also known as Saur Varsha or a solar year. It has been recorded in previous pages that rate of revolution of the Earth around the Sun is not static but it is increasing gradually from the day Prithivi or the Earth came into existence. Moreover, the distance between the Earth and the Sun is increasing at the rate of 1.5 cm per year and Prithivi will park itself 159 m away from the Sun in 10, 000 years. Consequently, the length of elliptic of the Earth will increase by 1 kilometer in 10,000 years. In addition to this development, in 16 million or 1, 60, 00, 000 years, the revolution of the Earth will increase by an hour. Therefore, 1970 million or 197 crore years ago, the Earth used to revolve around the Sun in 360 days. Incidentally, the Earth came into existence at that very time. It is striking to mention at this stage that in mega level Kal Ganana or Time Reckoning, and year was considered to be equal to 360 days.

Kal Maan or Time Unit for Beginning of a Year

The beginning of time of a year is related to Uttarayan concept as advocated by Rishi. It may be mentioned that present geographical disposition of the Earth has also not remained static during geological past. Therefore, it was not similar to the one existing at the time creation of Srishti or the Cosmos 197 crore or 1970 million years ago. At that time, the entire world was interlinked into one landmass known as Pangaea and it was located where present day Antarctica is situated. Whenever northern hemisphere aligned to face the Sun, beginning of a year was taken which also coincided with Vasant Sampat or Vernal Equinox on 21st March that also happened to be the beginning of Uttarayan, even though it has changed slightly now as discussed in previous pages. This is only reason that we have continued to maintain year beginning from Vasant Sampat or vernal equinox.

It is well known that Pangaea was broken into Laurasian and Baltic Shields, as well as Angara and Gondwana landmasses; that were separated by oceans. Geological inputs reveal

Gondwana land contained a landmass in which present day Australia, Indian Sub-continent, Africa and South America and was parked around south pole in the southern hemisphere. It came into existence during Proterozoic era sometimes around 2000 million or 200 crore years ago. Moreover, Indian sub-continent remained welded to Gondwana land located in higher latitudes in the southern hemisphere around 60 degree south latitude till Carboniferous epoch, almost 355 million or 35 crore and 50 lakh years ago. Later on, even Gondwana land was disintegrated into various segments under the impact of continental drift. Indian plate got detached from Australian landmass and started migrating northwards from Kumeru region or southern hemisphere. At the beginning of Cenozoic era, sometimes 65 million or 6 crore 50 lakh years ago, collusion of Indian plate with Asian plate commenced and Himalaya came into existence. At present, Indian plate has even crossed the equator as consequence of continental drift and got welded into Asian plate in the northern hemisphere and is parked between 8 and 37 degrees north.

Consequently, Uttarayan beginning was reckoned from the shifting of the Earth northwards from Makar Sankranti as enumerated in Vedang Jyotish. In case year beginning is taken from Uttarayan sankranti or transit, the present day beginning has to be accepted from this transit rather than Vasant Sampat or Vernal equinox. The beginning of present Kalp took place at sunrise on Chaitra or 1st lunar month Shukla or bright fortnight Pratipada or 1st Tithi or lunar day in Ashwini nakshatra or β Arietis constellation in Mesh rashi or Aries sign 197 crore or 1970 million years ago. Consequently, the year beginning has now been accepted to be taken from the above mentioned time of the creation of Srishti or the Cosmos. This is the reason why first nakshatra is taken as Ashwini, first rashi as Mesh and first Chandra Mas as Chaitra. Hence, Chaitra, Shukla Pratipada is that sensitive point of time which has been taken as beginning of a year.

Khedval, Devakinandan (1993)28 compiled various values of Varsh Maan as given in Table 22.

Table 22: Values of Varsh Maan By Different Authorities

Authorities	Days	Ghati	Pal	Vipal	Prativipal
Vedic Rishi	366	-	-	-	-
Vashisht Siddhant	366	-	-	-	-
Surya Siddhant	365	15	31	31	24
Brahmasaphut Siddhant	365	15	30	22	30
Pitamaha Siddhant	365	21	15	-	-
Grah Laghav	365	15	31	30	-
Jyotiraganit (Ketkar)	365	15	22	57	-
Lockier (constellation)	365	15	22	52	30
Lockier (Sayana)	365	14	31	56	-
Ptolemy (Sayana)	365	14	37	-	-
Arya Bhatta	365	15	31	15	-
Copernicus (Tropical)	365	14	39	55	-
Maitton (constellation)	365	15	47	2	10
Babaylonian (Constellation)	365	15	33	7	40
Vishnu Gopal Navathe	365	14	31	53	25

Authorities	Days	Ghati	Pal	Vipal	Prativipal
Modern European	365	15	22	56	52
Chandra Varsh (Lunar Year)	354	22	1	23	-
Savan Varsh	360	-	-	-	-
Brihaspatya Varsh or Jupiter Year.	361	1	36	11	-
Nakshatra Varsh or Constellation Year	371	3	52	30	-
Sour Varsh (prevalent one)	365	15	31	30	-
1 Day = 60 Ghati, 1 Ghati = 60 Pal, 1 Pal = 60 Vipal, 1 Vipal = Prativipal					

The perusal of above Table reveals that duration of a year has varied considerably as propounded by various authorities/ systems. It varies from 354 days (Chandra Varsh or lunar year) to 371 days (Nakshatra Varsh or Constellation Year). This variation is understandable since it is caused by different astronomical phenomena discussed earlier. As many as 21 different authorities have advocated Varsh Maan or a Year comprising 365 days but differ on specific details. Nevertheless, values given in Surya Siddhant are almost nearer to reality that has been applied by other Rishi also.

6.

MEGA LEVEL OF TIME RECKONING OR KAL GANANA

The appellation – mega level of Time Reckoning or Kal Ganana is an arbitrary expression in the present context and it is restricted to this book only as suggested in the previous chapter. The proposed classification of Kal Maan has primarily been done to facilitate the reader to clearly understand this intricate and subtle subject. This term denotes any portion of Time Measure or Kal Maan which is higher than one year. In the previous chapter, a detailed discussion has already elucidated Kal Maan or Time Measure from 37,969th part of a second (Ved Vyas) to a Varsh or a year. Therefore, this chapter of mega level of Kal Ganana deals with Kal Maan or Time Measure from the lapse of one year till times of antiquity when Srishti or the Cosmos was created. Therefore, it is amply clear that our Rishi carefully recorded data from beginning of the existence of the Cosmos and continued to maintain data sets till date.

In this context, Rishi or scientists observed two scientific principles that enabled them to record, synthesize and monitor mega level of Time Reckoning or Kal Ganana. These principles pertain to Yug Maan or Yug Measure and other astronomical parameters like planetary as well as galactic revolutions. Yug Maan or Yug Measure is responsible for groupings of years on scientific logic and observations and produced data sets that enabled scientists to compute samvat or calendars of smaller magnitude. On the other hand, planetary conjunctions and

revolutions were studied very systematically that gave rise to very distinct data sets which generated Kal Maan or Time Measures of very large magnitude.

A. Yug Maan or Yug Measure

A concept of Yug was evolved to measure higher time unit from a year up to 4.32 million or 43 lakhs and 20 thousand years in the initial stages and thereafter it was extended to further higher levels of time frame. This perception is based on a well known astronomical phenomenon i.e. time taken by all the planets of our solar system to conjoin with one another at a fixed astronomical reference point. It is quite obvious that onus of attaining the status of above mentioned reference point invariably fell on a nakshatra or constellation.

In order to initiate calculations of Yug Maan, a fixed number of years were grouped together in such a manner that is based on astronomical processes and in this case, it was recorded as a conjunction of some planets in a particular nakshatra or constellation. In order to undertake this concept to a logical conclusion in initial stages and that too at lower level, the luminaries of our solar system viz. the Sun and the Moon were studied for this purpose. The concept was further evolved by taking additional astronomical parameters.

Panch Varshya or 5- Year Yug

It is widely known that in geo – centric model, Surya or the Sun and Chandra or the Moon conjoins with each other every month on Amavasya or new moon day. On further analysis by Rishi, it was observed that the conjunction of luminaries i.e. the Sun and the Moon occurring in the month of Magh (11^{th} lunar month) on Shukla or bright fortnight in Pratipada or 1^{st} Tithi (lunar day) in Dhanishtha *nakshatra* or β Delphini or 23^{rd} constellation, takes place after a lapse of 5 years. On this stipulated day, Surya or the Sun is traversing in Uttarayan wherein northern hemisphere of Prithivi or the Earth is facing the Sun.

This is how Panch Varshya or 5-Year Yug has been developed. The same fact is enumerated in Vedang Jyotish:-

Svarakramerta somarko yada sakam sawasawao
Syat tadaadi yugm magha stapah shukloayanam hyuadik.[29]

Whenever the Sun and the Moon traverse in Dhanishtha nakshatra on Magh Shukla Pratipada, a Panch Varshya Yug commences in Uttarayan.

Therefore, in the tradition of Vedang Jyotish and Varahmihira School, the Yug started from Dhanishtha nakshatra. It is interesting to record here that another school of thought also became prevalent on this issue. Bhaskaracharya School believes in the Yug commencement from Ashwini nakshatra or β Arietis constellation. It may be added here that both these schools play an important role in the constitution of higher Yug that will be clear in later analyses and discussions.

It is needless to add that Panch Varshya Yug or 5 – Year Yug is the first time unit of mega level of or Time Reckoning or Kal Ganana from the commencement of Srishti or existence of the Cosmos. The name of the first year is Samvatsar which is followed by second one and continues till the fifth year. Thereafter, the cycle will repeat again with commencement of the first year and end in a similar manner.

Its perfinent data has been provided in Table 23.

The nomenclature of Panch Varshya or 5-Year Yug was based on meteorology. The scientists monitored all the parameters of weather science but concentrated on the occurrence and quantity of rainfall during specific months in a particular year. During those days, liquid precipitation had played very important role in development of society. It is interesting to record that our Rishi had registered a five year cycle on the basis of a single parameter i.e. liquid precipitation and its distribution in space.

Table 23: Nomenclature of years in Panch Varshya Yug

Sr.No.	Nomenclature of years	Sequence of Years	Quantity of Rainfall
1	Samvatsar	First	Equal quantity of rainfall in 4 months
2	Parivatsar	Second	Rainfall is restricted to Shravan & Bhadrapad months while scanty rainfall in other months.
3	Idavatsar	Third	Excessive rainfall in Shravan, Bhadrapad, Ashwin, and Kartik months.
4	Anuvatsar	Fourth	Rainfall occurs after the expiry of Chatur Mas.
5	Idvatsar	Fifth	Very scanty rainfall.

This pattern of rainfall must have been prevalent during those days which itself is an amazing scenario. It was Varahmihira who coined these terms and studied meteorological parameters in general and rainfall pattern in particular during *Chatur Mas* or four months when rains occur in abundance in our country.

Vrishti samaadya Pramukhe dvateeyay pramukh toya kathita triteeya
Pashchajjalam munchati yacheturtham swalpaudikam panchammandmuktam[30]

Samvatsar is the first year of Panch Varshya or 5 – Year Yug wherein rainfall occurs in almost equal quantity in all the four months or Chatur Mas viz. Shravan or 5th month, Bhadrapad or 6th month, Ashwin or 7th month and Kartik or 8th lunar month of a year. There is neither a lesser nor a higher rainfall in any of the above months. It implies that there will be good harvest during the year and the society will prosper.

Parivatsar is the second year of the Yug in which rainfall occurs only in first two months viz. Shravan and Bhadrapad. In remaining two months i.e. Ashwin and Kartik, a mere deficit rainfall is experienced. This weather pattern must have marginally affected the society as agricultural production would fall to some extent and society might have faced some economical pressures.

Idavatsar is third year of the Yug which is characterized by occurrence of excessive rainfall that is recorded in all the four months. It is quite evident that excessive flooding of major river systems would have been the order of the day that would be helpful in replenishing fertile soils of cultivable lands. Therefore, excessive production of harvest would bring boon to the society.

Anuvatsar is the fourth year of the Yug in which rainfall almost disappears in Varsha Ritu or rainy season. However, it

suddenly materializes only after the lapse of Chatur Mas or four months. The net impact of this phenomenon would be near drought conditions that are followed by excessive flooding in which the crops are extensively damaged that would adversely affect the economy of the society.

Idvatsar is the last year in which very scanty rainfall is experienced during the year and almost drought conditions prevail. Drought has ever been a dangerous scenario for the society as Indian economy has always remained agriculture oriented one.

Dvadash Varshya or 12 – Year Yug

Brihaspati or Jupiter plays a great role after Surya or the Sun and Chandra or the Moon in our Saur Mandal or solar system. Rishi Brihaspati was considered as guru by populace inhabiting the eastern hemisphere called as *Dev* since the Jupiter rises in the east and sets in the west like the Sun. On the other hand, people living in the western hemisphere were called *Asur* as Shukra or the Venus rises in the west and sets in the east. Therefore, Shukra was known as guru of *Asur*. Since there is a day light in the eastern hemisphere as it faces the Sun, it is termed as *Dev lok*. Similarly, western hemisphere becomes dark simultaneously, since no solar rays are received by it as the Sun is posited in the east. Hence, this geographical area is known as *Asur Lok*. Let it be made clear at this stage that these appellations merely reflect an astronomical connotation rather than any reference to gods or *Dev* and demons or *Asur* etc.

Brihaspati or the Jupiter revolves along its own orbit around the Sun during a span of almost 12 years. In other words, it traverses one Rashi or a Sign in one Brihaspati Varsh or Jupiter year that encompasses 361 days, 2 Ghati, 55 Pal and 25 Vipal corresponding to 361 days, 1 hour, 10 minutes and 10 seconds. This Kal Maan or Time Measure of one year is shorter by 4 days and 13 Ghati corresponding to 4 days, 5 hours and 12 minutes from Saur Varsh or solar year. Consequently, this

difference in values gets cumulated to one year in 85 Brihaspati Varsh or Jupiter years. Therefore, one year is decremented as compared to solar year.

Nakshatra or constellations play a significant role in the nomenclature of Brihaspati or Jupiter Yug. Name of a Brihaspati Varsh or Jupiter year is known on the basis of location of Brihaspati or the Jupiter in a particular Rashi or a sign. For example, if Brihaspati is posited in Mesh or Aries rashi or sign, the said year is called as Ashwin based on Ashwini nakshatra or β Arietis constellation. If Brihaspati is posited in Rishabh rashi or Taurus sign, year name would be Krittika. Similarly, remaining years will be termed as Margsheersh, Poush, Magh, Phalgun, Chaitra, Vishakh, Jyeshth, Ashalesha, Shravan and Bhadrapad respectively. In other words, these names are similar to the names of lunar months.

At present, Brihaspati is transiting in Tula rashi or Libra sign. Accordingly, the name of Brihaspati Varsh will be Chaitra Varsh.

Shasht Varshya or Sexagenary Yug

The computation of Shasht Varshya or Sexagenary Yug involves the principle of integration of both above mentioned Panch Varshya or 5 - Year and Dvadsh Varshya or 12-Year Yug. In this sub – system, 12 cycles of Panch Varshya or 5 – Year Yug and 5 cycles of Jupiter or 12 - Year Yug were incorporated. Therefore, the evolution of this concept emerged in studying certain parameters dispersed in sixty years, were found to possess some commonalities that will be enumerated at a later stage.

In Shasht Varshya or Sexagenary Yug, two schools of thought exist amongst Rishi or scientists concerning its inception. Bhaskaracharya propagated its origin from the time of beginning of Kalp, (a super mega time unit to be discussed at a

later stage in this chapter) when all planets including Brihaspati or the Jupiter were posited in Ashwini nakshatra or β Arietis constellation. On the other hand, Varahmihira advocated that Shasht Varshya or 60 – year Yug started when Surya or the Sun, Chandra or the Moon and Brihaspati or Jupiter were posited in Dhanishtha nakshatra or β Delphini constellation on Magh (11th lunar month) Shukla (bright fortnight) Pratipada (1st lunar Tithi or day). This event occurs after a lapse of 864 million (86 crores and 40 lakh) years from the beginning of the present Kalp and recurs only five times during the entire span of a Kalp.

In Vishnudharmotra Puran, the following shlok elucidates the above mentioned point.

Magha shuklasamarambhey chandrarko vaasavarakshgau Jeevyuktau yada syatam shashtyabdadistada bhavaita[31]

It states when Surya, Chandra and Brihaspati conjoin together in Dhanishtha nakshatra, 60 – year Yug begins.

However, the sequence of terms of Shasta Varshya or 60 – year Yug as propounded by Bhaskaracharya as well as Varahmihira has been tabulated by Arya (1998)[32] as given in Table 24.

The nomenclature of years pertaining to Shasht Varshya or Sexagenary Yug advocated by Bhaskaracharya as well as Varahmihira, are almost similar but these two authorities differs in deciphering the beginning of the Yug. It is quite apparent that Bhaskaracharya year in the Yug begins with Vijay. On the other hand, votaries of Varahmihira School believe that Yug begins with Prabhav year which happens to be 35th year of Bhaskaracharya scheme.

Table 24: Shasht Varshya or Sexagenary Yug

Sr.No.	Year Name		Sr.No.	Year Name	
	Varahmihira	Bhaskaracharya		Varahmihira	Bhaskaracharya
1	Prabhav	Vijay	31	Hemlamb	Rudhirodgaari
2	Vibhav	Jay	32	Vilamb	Raktaksha
3	Shukla	Manmath	33	Vikari	Krodhi
4	Pramod	Durmukh	34	Kshya	Kshya
5	Prajapati	Hemlamb	35	Plav	Prabhav
6	Angir	Vilamb	36	Shubhakrit	Vibhav
7	Shrimukh	**Vikari**	37	Shobhan	Shukla
8	Bhav	Kshya	38	Krodhi	Pramod
9	Yuva	Plav	39	Vishwavasu	Prajapati
10	Dhata	Shubhakrit	40	Parabhav	Angiras
11	Ishwar	Shobhan	41	Plavang	Shrimukh
12	Bahudhanya	Krodhi	42	Keelak	Bhav
13	Pramathi	Vishwavasu	43	Saumya	Yuva
14	Vikram	Parabhav	44	Sadharan	Dhatru

Sr.No.	Year Name		Sr.No.	Year Name	
	Varahmihira	Bhaskaracharya		Varahmihira	Bhaskaracharya
15	Vrisha	Plavang	45	Virodhakrit	Ishwar
16	Chitrabhanu	Keelak	46	Paridhavi	Bahudhanya
17	Subhanu	Saumya	47	Pramadi	Pramathi
18	Taaran	Sadhaaran	48	Anand	Vikram
19	Paarthiv	Virodhkrit	49	Rakshus	Vrisha
20	Vyaya	Paridhaavin	50	Anal	Chitrabhanu
21	Sarvajit	Parmaadin	51	Pingal	Subhanu
22	Sarvadhaari	Anand	52	Kaalyukta	Taaran
23	Virodhi	Rakshus	53	Siddhartha	Paarthiv
24	Vikriti	Anal	54	Roudra	Vyaya
25	Khar	Pingal	55	Durmati	Sarvajit
26	Nandan	Kalyukta	56	Dundhubhi	Sarvadhaari
27	Vijay	Siddhartha	57	Rudhirodgaari	Virodhi
28	Jay	Roudra	58	Raktaksha	Vikrit
29	Manmath	Durmati	59	Krodhi	Khar
30	Durmukh	Dundhubhi	60	Kshya	Nandan

At this stage, one could get a notional feeling that a controversy has developed concerning beginning of the year in this Yug. It could have led one to believe that these views have given rise to rigid sectarianism in this Yug. Nevertheless, this difference of opinion between two schools of thought lies in the basic perception of super mega level of Kal Maan. The votaries of Bhaskaracharya School advocate inception of the Yug from conjunction of Brihaspati or the Jupiter along with all other planets in first nakshatra called Ashwini or β Arietis constellation in Mesh rashi or Aries sign. Incidentally, this significant conjunction of all the planets was also prevalent at the beginning of the Kalp. The following shlok from Surya Siddhant clarifies this concept:-

Dvadashdhna guroyarta bhagna varta maankaiyh
Rashiabhihi sahitah shudhhah shashthya syurvijayadyah[33]

On the other hand, scientists of Varahmihira School recognise commencement of Shasht Varshya or Sexagenary Yug from the conjunction of Brihaspati or the Jupiter with Surya or the Sun and Chandra or the Moon in Dhanishtha nakshatra or β Delphini constellation in Kumbh rashi or Aquarius sign; as it is clear from the following shlok by Varahmihira:-

Adyadhanishtaamaanshamabhiprapannou Maghaey yada yaatyudayam surayjyaha
Shashtyabdapoorvah prabhavah sa naamna prapdyatay bhoothitastabdah[34]

It has been pointed out earlier that the aforesaid conjunction of planets in Dhanishtha nakshatra does not occur at beginning of a Kalp but this scenario develops after a lapse of 864 million (86 crore and 40 lakh) years. It is interesting to mention that at the time of conjunction of above mentioned planets in Dhanishtha nakshatra, Bhaskaracharya 35th samvatsar or year called Prabhav was in progress. This is the reason why name of the first year of Varahmihira Sexagenary Yug is known as Prabhav.

It is further added that the transit of Brihaspati or the Jupiter in

Dhanishtha nakshatra or β Delphini constellation in Kumbh rashi or Aquarius sign is considered very auspicious and world famous Kumbh fair is celebrated during this period.

In Table 25, various years of 60 – year Yug occurring in different rashi, nakshatra and Mas or sign, constellation and month occurring in cyclic dispensation are recorded on the basis of Table given by Arya[35] (1998).

The reason of the sequence of appellations of years is based on specific characteristics of those years as expounded by Bhaskaracharya. For example, the scrutiny of above Table reveals that the names of year of this Yug in 3rd cycle of Poorv bhadrapad nakshatra is given as Vibhav whereas that of 4th cycle of Ashwini, Krittika and Mrigsheera nakshatra are respectively Shukla, Pramod and Prajapati. The reason was observed to be that populace during these years used to be prosperous, free from fear and worries and ruled by pious kings. Varahmihira writes the following shlok to corroborate it.

Nishpanna shalikshuyuvadisanstha bhairvimuktamupshanta vairama
Sanhrishtha lokam Kalidoshmuktam kshatram Pad shasti bhootghatreem[36]

Similarly, Bhaskracharya has enumerated events that were responsible for the nomenclature of all 60 years of the Yug. On the other hand, Varahmihira also propounded his reasons for the characteristics that accounted for nomenclature of all the years of the Yug. It may be added here that samvatsar or years from first to twenty are called Braham Vishanti; twenty first to forty are known as Vishnu Vishanti and forty one to sixty are Rudra Vishanti.

Jha[37] (1985) tabulated important properties that are recorded in Table 26.

Table 25: Bhaskaracharya's Sexagenary Yug

Sequence of 60 - year Yug as per Sign, Constellation and Month												
Rashi	Nakshatra	Mas	No	Name	No	Name	No	Name	No	Name	No	Name
Mesh	Ashwini	Chaitra	1	Vijay	13	Vishwavasu	25	Pingal	37	Shukla	49	Vrisha
Rishabh	Krittika	Vishakh	2	Jaya	14	Parabhav	26	Kaalyukta	38	Pramod	50	Chitrabhanu
Mithun	Mrigsheera	Jyeshth	3	Manmath	15	Plavang	27	Siddhartha	39	Prajapati	51	Subhanu
Karkat	Punarvasu	Ashadh	4	Durmukh	16	Keelak	28	Roudra	40	Angira	52	Taran
Simha	Magha	Shravan	5	Hemlamb	17	Saumya	29	Durmati	41	Shrimukh	53	Paarthiv
Kanya	Utt.Phalg.	Bhadrapad	6	Vilamb	18	Sadharan	30	Dundhubhi	42	Bhavas	54	Vyaya
Tula	Chitra	Ashwin	7	Vikari	19	Virodhkrit	31	Rudhirodgaari	43	Yuva	55	Sarvajit
Vrishchik	Vishakha	Kartik	8	Sharvri	20	Pardhavi	32	Raktaksh	44	Sudhata	56	Sarvadhaari
Dhanu	Moola	Marg.shr	9	Plav	21	Pramadi	33	Krodhi	45	Ishwar	57	Virodhi
Makar	Uttar sha.	Poush	10	Shubhakrit	22	Anand	34	Kshya	46	Bahudhanya	58	Vikrit

Sequence of 60 - year Yug as per Sign, Constellation and Month													
Rashi	Nakshatra	Mas	No	Name	No	Name	No	Name	No	Name	No	Name
Kumbh	Dhanishtha.	Magh	11	Shobhan	23	Rakshus	35	Prabhav	47	Pramathi	59	Khar
Meen	Poorv.bha.	Phalgun	12	Krodhi	24	Anal	36	Vibhav	48	Vikram	60	Nandan

Table 26: Properties of Shasht Varṣhya or 60 - Year Yug (Varahmihira)

12 - Year Yuga	Year Ownership	Properties	5 Year Yug				
			Samvatsar	Parivatsar	Idavatsar	Anuvatsar	Idvatsar
			Plenty rain	Rain	Excess Rain	Delayed rain	Scanty rain
1	Vishnu	Uttam	Prabhav 1	Vibhav 2	Shukla 3	Pramod 4	Prajapati 5
2	Jeev		Angir 6	Shrimukh 7	Bhav 8	Yuva 9	Dhata 10
3	Indra		Ishwar 11	Bahudhanya 12	Pramathi 13	Vikram 14	Vrisha 15
4	Agni		Chitrabhanu 16	Subhanu 17	Taaran 18	Paarthiv 19	Avyaya 20
5	Tvashta	Madhyam	Sarvajit 21	Sarvadhaari 22	Virodhi 23	Vikriti 24	Khar 25
6	Ahirbudhanya		Nandan 26	Vijay 27	Jay 28	Manmath 29	Durmukh 30
7	Pitar		Hemlamb 31	Vilamb 32	Vikari 33	Sharvri 34	Plav 35

12 - Year Yuga	Year Ownership	Properties	5 Year Yug				
			Samvatsar	Parivatsar	Idavatsar	Anuvatsar	Idvatsar
			Plenty rain	Rain	Excess Rain	Delayed rain	Scanty rain
8	Vishwadev		Shubhakrit 36	Shobhan 37	Krodhi 38	Vishwavasu 39	Parabhav 40
9	Som	Adham	Plavang 41	Keelak 42	Saumya 43	Sadharan 44	Virodhakrit 45
10	Agni		Pardhavi 46	Pramadi 47	Anand 48	Rakshus 49	Anal 50
11	Nasatya		Pingal 51	Kaalyukta 52	Sidharti 53	Roudra 54	Durmati 55
12	Bhag		Dundhubhi 56	Rudhirodgaari 57	Raktaksha 58	Krodhi 59	Kshya 60

In Table 26, interesting information has emerged by integrating the properties of all the above three described Yug. For instance, years of Sexagenary Yug have been grouped into three distinct groups. First category is called Uttam or superior that includes first 20 years; 21 to 40 years have been contained in Madhyam or medium category whereas Adham or poor category incorporates 41 to 60 years.

The study of climatological parameters reveal that normal rainfall is experienced in four months during 1,6,11,16,21, 26,31,36,41,46,51 and 56th years of Sexagenary Yug. Excessive liquid precipitation causes very heavy flooding in 3, 8, 13,18, 23,28,33,38,43, 48, 53 and 58th year of the Yug. Similarly, scanty rains leading to almost drought like conditions are noticed in all those years that are divisible by five such as 5, 10, 15, 20 etc. in 60 – Year Yug. It is quite evident that such data sets had wide applied applications in the society in the sense that economy of the state could be protected with judicious use of this valuable knowledge.

It is strikingly prudent to summerise as well as address astronomical phenomena that contribute to such Yug Maan or Measure of mega level of Time Units at this stage so that its scientific validity is established beyond doubt. These heavenly activities have been listed by the author in Table 27.

Close study of the data in Table clearly demonstrate that the Yug Maan or Yug Measure heavily depends upon two independent natural parameters. Varahmihira concept of planetary conjunction is one aspect and another one is revolution of one of the planet of Solar System around the Sun. Moreover, the use of data sets for the benefit of society has clearly been demonstrated. Therefore, it can safely be argued that our Rishi were very concerned about the utilization of the scientific research for the benefit of mankind. It is implicit that rulers of the day could take adequate pre-emptive measures so

that no undue economic or social pressures could adversely affect the masses.

Table 27: Astronomical Basis of Panch, Dvadash and Shasht Varshya Yug

S.No.	Phenomenon	Time Reckoning
1.	Conjunction of the Sun, and the Moon on Magh Shukla Pratipada in Dhanishtha Nakshatra (Varahmihira Concept)	Panch Varshya or 5 – year Yug
2.	Revolution of Brihaspati or Jupiter Around the Sun	Dvadsh Varshya Or 12- year Yug
3.	Conjunction of the Sun, Moon and Jupiter in Magh Shukla Pratipada in Dhanishtha nakshatra (Varahmihira concept)	Shasht Varshya Or Sexagenary Yug

Saptrishi or Ursa Major Yug

Saptrishi or Ursa Major is a group of seven luminary stars that are located outside our Solar System and constellations in Milky Way or our galaxy. These stars are arranged in a particular manner which is noticeable in night sky even with naked eyes. Saptrishi or Ursa Major is very popular that are well known even to illiterate persons of our country. It finds a wide application in astronomy, geography and culture of the land. Saptrishi or Ursa Major had attracted attention of Rishi also. It is interesting to record that the term Rishi also signifies a luminary star.

The nomenclature of Saptrishi or Ursa Major is based on seven great Rishi or hermits of ancient times who were great astronomers. They are addressed as Marichi, Vasishth, Angira, Atri, Pulastya, Pulah and Kratu. Another illuminating star is found adjoining Vasishth which is named after his wife, Arundhiti. These seven Rishi were so well known during those days that even gotra system was created that completely got imbibed in the society. The gotra are named after these famous

scientists and this system is prevalent even today. Varahmihira in his famous treatise, Brihatsamhita clearly elucidates the intricacies of Saptrishi. Pertinent shlok in this context is given below:

Purvey baggy bagman marichiparay sthithou vasishthauasmat
Tasyaangirastatoattristyasanna pulastyayshcha
Pulah kraturiti bhagwanasanna anukramaina poorvaadyat
Tatra vasishtham munivarmupashritarundhiti sadhvi[38]

In above shlok or verse, Varahmihira has described the astronomical disposition of Saptrishi or Ursa Major. Marichi is the first luminary star in Saptrishi or Ursa Major that is located in the eastern most part. Further, in the sequence is Vasishth which is followed by Angira and Atri. Near Atri and down below, Pulastya is located. Thereafter, Pulah and Kratu are found. Yet another illuminating star is observed almost in conjunction with Vasishth. It is known as Arundhiti who happened to be the consort of Rishi Vasishth.

In the Table 28 astronomical nomenclature of Saptrishi or Ursa Major is given.

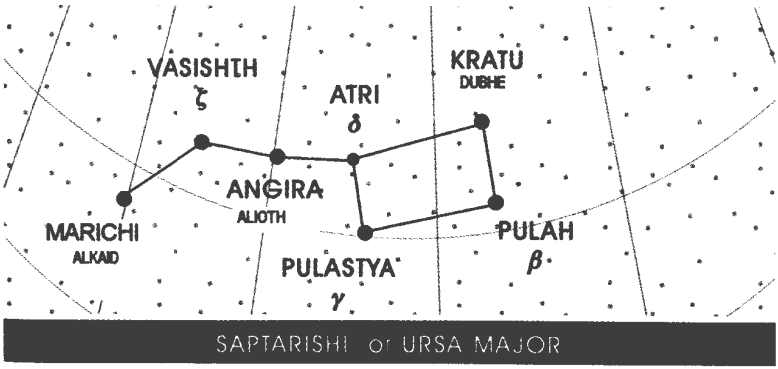
Table 28: Luminary stars of Saptrishi or Ursa Major

S.No.	Saptrishi	Names of stars of Ursa Major
1	Marichi	Alkaid
2	Vasishth	ζ
3	Angira	Alioth
4	Atri	δ
5	Pulastya	γ
6	Pulah	β
7	Kratu	Dubhe

Our Rishi calculated that even Saptrishi or Ursa Major is not static with reference to the Earth but discerned some motion in it. They noticed that Saptrishi revolve around our solar system. Varahmihira narrates:-

Saptarishyastu tishthanti paryayana shatma shatam Yakaikasminnakshatray shatma shatma te charanti Varshnam[39]

It is informative to add that Saptrishi transit one nakshatra or constellation for a hundred years. Twenty seven nakshatra or constellations have been delineated as mentioned earlier. Therefore, Ursa Major will take 2700 years to complete one revolution. In other words, Saptrishi Yug will take 2700 years for its completion. Bali (2005)[40] mentioned that 18 years; known as Sansarp Kal; are added to above figure for linkage with Saur Ganana or Solar calculations. Therefore, one Saptrishian or Ursa Major cycle or year encompasses 2718 years.



SAPTARISHI or URSA MAJOR

Moreover, the domain of each nakshatra or constellation is 13 degrees 20 minutes or 800 minutes. Therefore, Saptrishi or Ursa Major traverses 8 minutes during one year. At present, Saptrishi have been transiting in Ardra nakshatra or α Orionis constellation and completed their 75th year in the constellation in 1998 A.D. In other words, it has been calculated that Ursa Major are traversing 11 degree and 04 minutes in this nakshatra in 2006 A.D. Therefore, it is clear that Saptrishi or Ursa Major entered Ardra nakshatra or α Orionis constellation in 1923 A.D.

It is stated that Saptrishi had entered Magha nakshatra or α Leonis constellation 75 years prior to the beginning of Kaliyug i.e. (3102 + 75 = 3177 B.C.) or 5183 years ago. Moreover, there is a difference of 24 nakshatra between Magha or α Leonis constellation and Ardra or α Orionis constellation. Therefore, Kaliyug started 2700 + 2408 = 5108 years ago. This is yet another tool that has been deployed to date mega events of our Itihas (≡ history?).

Even in deciphering Saptrishi Yug, scientists were not unanimous in deciding the beginning of this Yug. Scientists of Patna School believed that this Yug began when Saptrishi or Ursa Major was located in Revati nakshatra or ζ Piscium constellation. On the other hand, followers of Kashmir School adhered to the opinion that Rohini nakshatra or α Tauri constellation was the inception constellation for this Yug. Their only argument was confined to observation that Saptrishi was transiting Rohini nakshatra at the time of creation of Srishti or Cosmos. The difference between the two nakshatra is four. Consequently, the difference of reckoning between the two Schools works out to be 400 + 5 = 405 years. Therefore, Patna Saptrishi Yug is 405 years ahead of Kashmir Saptrishi Yug (5 years error is the fixation of Yogtara of Saptrishi or Ursa Major). This Yug was very commonly utilized during Mahabharat period but its popularity dwindled during subsequent era.

B. Divya Maan or Divya Measure

Vedic Rishi had already discovered that the Earth is inclined on its axis. Tilak in his Orion (pp.158) quotes Prof. Ludwig to elucidate this piece of information. Prof. Ludwig goes further to add that Rig Ved mentions the inclination of ecliptic with the equator (1.1.10) and the axis of the Earth (10.89.04). Vedic Rishi also knew that north and south poles of the Earth remain suspended towards Surya or the Sun due to above mentioned inclination. Hence, polar region experiences day and night for six month duration. A richa from Atharav Ved has been re–produced below to provide additional information:-

Vishvanarasya pratimopari dyouryavadrodsi vibabadhey agnih Tatah shashtadamuto yanti stoma udito yatanaybhi shasthanh[41]

In the above shlok, path of the ecliptic has been described. Rishi called ecliptic as Vaishwanar path. It has been explicitly demarcated by combining the trace of Dhanu or Sagittarius, Kumbh or Aquarius and Meen or Pisces rashi or signs. On ecliptic or Vaishwanar path, Surya or the Sun remains confined on one side for six segments and other six segments remain on the other side. It implies that the polar region of the Earth experiences day light for six months and night for the equal duration.

It is a well known fact that location of poles of the Earth has not remained stationary in geological past. Magnetism is registered in rocks which gives indication of location of poles. Therefore, mapping of signature of palaeo – magnetism in rocks of a known age can clearly indicate direction in which poles were existing during that period in geological history. Important geological evidence is the occurrence of certain deposits in an alien environment. The classical example of this parameter pertains to the study of rocks on Antarctica continent. It is a common knowledge that present Antarctic

region is capped by a thick pile of snow and ice. In other words, very cold climatic conditions exit on this continent where the lowest temperature ever recorded in one of research stations has been minus 87 degrees Celsius.

During geological reconnaissance of Antarctica continent, thick seams of coal have been discovered under a huge pile of snow and ice. Presence of coal seams on the polar continent clearly points towards alien environment. The coal seam is formed in a very warm, humid and marshy environment. Therefore, when coal seams were under process of formation on Antarctica continent during geological past, the above mentioned environment existed that was conducive to their formation. It specifically indicates that location of the South Pole was somewhere else while very high surface temperature, humid and wet climate and marshy conditions were prevailing at that time on Antarctica. In short, this phenomenon is known as polar wandering which has been recorded in many sequences of rocks of different geological epochs.

Therefore, North Pole of Prithivi or the Earth was facing Surya or the Sun at the time of the sunrise during the time of inception of Srishti or creation of the Cosmos. Consequently, there was a persistent day light in the northern hemisphere or Sumeru for a period of six months. Conversely, the southern hemisphere or Kumeru was located in opposite direction away from the Sun. Hence, six months of darkness prevailed in the southern hemisphere at that time. In order to signify this scenario, a metaphor nomenclature was evolved to denote certain terminology that found a wide usage. Thus, northern hemisphere that possessed six months of day light at that time was called Dev Lok or Divine world. Similarly, the southern hemisphere having six months of darkness at that time was termed as Danav Lok or Demon world. Therefore, one day of Dev Lok in northern hemisphere was equivalent to six months at the equator of the Earth. Moreover, the equatorial region was very heavily populated by human beings as compared to Polar

Regions. Therefore, this sector was known as Manav or Manushya Lok or human region. It clearly implies that one day of Dev and Danav Lok put together accounted for one year of Manav or human beings. Similarly, one Dev year is equivalent to 360 Manav or human years.

Eka va yetaddayvanamha yat Samvatsarh[42]

It is once again emphasized at this stage that Dev or Divine or gods and demons or Asur are merely metaphors that denote only geographical locations on the Earth and has no other indication or innuendo whatsoever.

C. Mahayug or Chatrur Yug Maan or Quadruple Measure

Our Rishi followed three fold approaches in grouping still higher levels of Kal Maan or Time Measure. Fundamental concept adopted for achieving the above objective was transit of various planets and amalgamation of multiplicity of smaller Maan or Measures.

The first approach adopted was combination of Laghu Yug like Panch Varshya or 5 – year and Dvadash Varshya or 12 – year Yug. 5 – Year span constitutes first Laghu Yug and 12 Laghu Yug account for Second Laghu Yug of (5x12) 60 years. 12 Second Laghu Yug give rise to Third Yug of (5x12x12) 720 years. Finally, 600 third Laghu Yug constitute one mega time unit called Kaliyug which works out to be 5 x 12 x 12 x 600 = 4,32,000 years or 0.432 million or 0.432 x 106 years.

The second approach was almost similar in concept as described but different time units were taken. Instead of Manav or human years, Kal Maan or Time Measure taken into consideration was Divya Varsh or divine year. One Shasht Varshya or Sexagenary Divya or divine year accounts for 21,600 Manav or human years and 20 such Yug cater to 4, 32,000 or 0.432 million years or time unit called Kaliyug.

However, our Rishi adopted the most common approach that deals with astronomical phenomenon. It involved transit of all the planets of our solar system. Rishi or scientists observed that in geo – centric model, all the planets of our solar system conjoin in Mesh rashi or Aries sign in Ashwini nakshatra or β Arietis constellation once in every 4,32,000 or 0.432 million or 0.432×10^6 Manna or human years. This time unit, as mentioned earlier, is known as Kaliyug. Moreover, 1000 Dev Varsh or Divine years coupled with two periods of Sandhi Kal or twilight zones of 100 Dev Varsh or divine years each also corresponds to Time unit of 0.432 million Manav or human years, called Kaliyug.

The years of Sandhi Kal or twilight correspond to the occurrence of catastrophes or natural disasters but these are restricted to certain geographical areas only. This phenomenon of deluge or marine transgression is not universal but remains confined to limited areas. Its classical example is the rise of sea level on west coast of India or Bharat during the end of Mahabharat period which is well documented. As a consequence of this phenomenon, Dwarka region in Gujarat got submerged under the Arabian Sea during the Sandhi kal or twilight period at the end of Dvaper Yug and beginning of Kaliyug of the current Mahayug.

If conjunction of all the planets takes place twice in Ashwini nakshatra in Mesh rashi or a period of 0.432 million years; this time unit is known as Dvaper. In Treta, this phenomenon occurs thrice whereas Satiyug has repetition of four such cycles of time unit called Kaliyug. Poddar[43] (2000) provided the basis for generating the entire data set that is incorporated in Table 29.

Table 29: Mahayug Or Chaturyug Or Quadruple Yug

Yug	Ratio	Sandhya Kal or Twilight		Niyat Kal or Fixed value		Sandhya Kal or Twilight		Total	
		Divya Varsh	Manav Varsh (million)	Divine Years	Human Years (million)	Divine Years	Human Years (million)	Divya Varsh	Manav Varsh (millions)
Kaliyug	1	100	0.036	1000	0.36	100	0.036	1200	0.432
Dvaper	2	200	0.072	2000	0.72	200	0.072	2400	0.864
Treta	3	300	0.108	3000	1.08	300	0.108	3600	1.296
Satiyug	4	400	0.144	4000	1.44	400	0.144	4800	1.728
Mahayug								12000	4.32 or 43,20,000 Manav years

The term Kaliyug has been utilized in many ways but the perusal of the above Table reveals that Kaliyug is nothing else but a Time Unit and that too, at mega level whose domain works out to be 0.432 million Manav or human years. Next, Dvaper incorporates two cycles of the years of Kaliyug Kal Maan that is calculated to be 0.864 million years. Similarly, Treta possesses three cycles of the number of years of Kaliyug or 1.296 million years while Satiyug incorporates four such cycles of Manav years that works out to be equivalent to four Kaliyug or 1.728 million years. The mega time unit of all the four Yug combined is called Mahayug or Chaturayug or Quadruple Yug which encompasses 4.32 x 106 or 4.32 million or 43 lakhs and 20 thousand Manav years. In other words, human years pertaining to 10 Kaliyug will constitute one Mahayug or Chaturayug. The Mahayug is also an embodiment of Dharm. Rishi of Manusmirti has codified 10 charan or units of Dharm:

Dhritikshma damoustayam Shoucham indriyanigraha
Dhirvidyaukrodho dashakam dharma lkshanam[44]

Rishi used a subtle terminology and suggested that one Charan or unit of Dharm exists in Kaliyug, two charan in Dvaper, three Charan in Treta and four Charan in Satiyug. In fact, this Charan attribution perhaps has other implications than Dharm also such as a simple manifestation of time units only.

Basis of Kaliyug Maan or Measure

As mentioned earlier, all planets and the Moon conjoin in Ashwini nakshatra or β Arietis constellation of Mesh rashi or Aries sign and return to the same position after a lapse of 0.432 million or 4 lakhs and 32 Manav Varsh or human years. The present Kaliyug commenced at 02 hrs 27 minutes and 30 seconds on 20th February 3102 B.C. which works out to be 5108 years ago in 2006 A.D. In other words, only very early stages of Kaliyug has elapsed and 4, 26, 892 years have to be experienced before Satiyug of next cycle of Mahayug starts.

Furthermore, Count Bjornstjerna[45] has reported the results of the famous astronomer of Europe, Belly who stated that according to astronomical calculations of the Hindus, the present period of the world, *Kaliyug*, commenced 3102 years before the birth of Christ on 20th February at 02 hours 27 minutes and 30 seconds, the time being thus calculated to minutes and seconds. They say that a conjunction of planets then took place and their Table shows this conjunction. It was natural to say that a conjunction of the planets then took place. The calculations of Brahmins are exactly confirmed by our own astronomical Tables that nothing but actual observation could have given so correspondent a result.

Dates of Beginning of the Present Mahayug

The present Mahayug is the 28th Mahayug which began with Satiyug. It started in 1st Prahar (first part of forenoon), Budhavar or Wednesday in Bridhi yoga, Shravan nakshatra or α Aquilae constellation, Navami (9th lunar day) of Shukla Paksha or bright fortnight of Kartik Mas or 8th lunar month. Similarly, its Treta Yug started in Dvateeya Prahar or second part of forenoon, Somvar or Monday, Shobhan yog, Rohini nakshatra or α Tauri constellation, Triteeya (3rd lunar day) and Shukla Paksha of Vaishakh Mas (2nd lunar month). Also, Dvaper Yug started in Triteeya Prahar (early part of afternoon), Baiyan yog, Dhanishtha nakshatra or β Delphini constellation, Shukravar or Friday and Amavasya or new moon day of Magh Mas or 11th lunar month. The beginning date of the Kaliyug has very specifically been described in earlier pages.

D. Manvantar Maan or Measure

Still higher time unit was recognized in which process of reversal of world order takes place. Moreover, polarity of the Earth also changes due to the phenomenon of polar wandering in this super mega time unit. There appears to be a direct correlation between geological and astronomical phenomena during this super mega time unit. Rishi discovered five cosmic systems pertaining to involution of creative activity in

ascending order from luminary sooksham or subtle to sthool or gross of different lok or worlds. These cosmic systems are intrinsically related to one another. The smallest system revolves around the next larger one in such an ascending order that encompasses the entire Cosmos. These five systems are enumerated below:-

- Chandra Mandal or the Moon System
- Prithivi Mandal or the Earth System
- Surya Mandal or the Sun System
- Parmeshthi Mandal or Galactic or Milky Way System
- Svayambhuv Mandal or Super Galactic System

In the creation of the Cosmos, each Mandal or System is sustained by the one that succeeds it and are dependant on one another. The first and the smallest system is Chandra Mandal or the Moon system that revolves around Prithivi or the Earth. This smallest system or Chandra Mandal is responsible for computing time units from micro levels to macro level i.e. up to months. It is followed by Prithivi Mandal or the Earth system that revolves around the Sun and contributes to the creation of time units up to years. Surya Mandal or the Sun or solar system is the next higher system that revolves around Parmeshthi Mandal or Galactic or Milky Way system. Poddar[46] (2000) has stated that Dhanu rashi or Sagittarius sign is located somewhere near the centre of Milky Way or our galaxy. One aforesaid revolution around the centre of Parmeshthi Mandal gives rise to a super mega time unit called Manvantar. Next one is the largest ever system and is known as Parmeshthi Mandal or Galactic or Milky Way system (in which our solar system is situated). It also revolves around Svayambhuv Mandal or Super galactic system (or the centre of galaxies of the Cosmos). This astronomical phenomenon gives rise to a yet still highly super mega time unit called Kalp which is a day in Brahma's life.

Table 30 includes astronomical phenomena that accounts for mega level of Kal Maan or time units.

Table 30: Astronomical Basis of Mega Level of Kal Maan or Time Units

Sr.No.	Phenomenon	Time Reckoning
1.	Revolution of Saptrishi or Ursa Major around all the nakshatra or constellations	2700 year Yug
2.	Conjunction of all planets including the Moon in Ashwini nakshatra in Mesh sign	Completion of one Yug of 0.432 million years called **Kaliyug**
3.	Mahayug or Chatur Yug or Quadruple Yug	Kaliyug + Dvaper + Treta + Satiyug = 4.32 million years Or 43,20,000 years
4.	Revolution of Solar system around the Parmeshthi Mandal or Galactic centre or Centre of Milky Way	One Manvantar or 30,84,48,000 years Or 308.448 million Years
5.	Revolution of Parmeshthi Mandal around Svyambhuv Mandal or Galactic centre Of the Cosmos	One Kalp or one day in Brahma's life or 4320 million years 14 Manvantar + Twilight equivalent to Satiyug or 1000 Mahayug

As stated earlier, revolution of Surya Mandal or solar system around Parmeshthi Mandal or Galactic or Milky Way centre is a phenomenon that contributes to a super mega time unit called Manvantar. During this time unit many changes like polar

wanderings, Jalpalavan or marine transgression on yet a very large scale etc. takes place.

There is yet another relationship that was adopted by Rishi to compute one Manu Kal or Measure or Manvantar:-

Manvantar Kal = 71 Mahayug + 1 Sandhi Kal (equal to 1 Satiyug value).

Sandhi Kal or Twilight period in each Manvantar is equivalent to the value of one Satiyug Maan or Measure i.e. 1.728 million years. A Mahayug has already been explained earlier having a Kal Maan of 4.32 million years. Therefore, one Manvantar Kal is also calculated as:-

Manvantar Kal = 71 x 4.32 million + Sandhi Kal or Twilight equivalent to Satiyug Maan or Measure
= 306.72 million years + 1.728 million years
= 308.448 million years

This figure incidentally is the same value for the time taken by our solar system to revolve around Parmeshthi Mandal or galactic or Milky Way centre.

A Sandhi Kal or Twilight is the period of transition from one Manvantar to another one. Bhaskaracharya advocated that this Sandhi Kal which is equivalent to Satiyug Maan or 1.728 million years is the period of Jalplavan or deluge induced by wide spread rise in sea level due to marine transgression. It is but natural that Jalplavan or deluge will cause massive destruction of life and major changes in land forms would take place. A continuous onslaught of deluge for 17 lakh and 28 thousand years will wipe out almost anything alive. However, some life would positively escape this deluge. Thus, after completion of 308.448 million years, a new Manu is able to escape the onslaught of Jalplavan or deluge of the previous Manvantar and begins the life and social structure again.

As per modern astronomical calculations, Surya Mandal or Solar System revolves around Parmeshthi Mandal or Milky Way or our galaxy at the rate of 250 km per second along its $2x10^{18}$ kilometers long orbit in 250 to 270 million years. However, our Rishi computed this value to be 308.448 million years. In other words, the Solar System takes 308.448 million or 308.448 x 10^6 years to complete one revolution around the galactic centre and this value is called one Manu or Manvantar. It is interesting to record at this stage that modern astronomers compute one revolution of the Solar System around the galactic centre in 250 to 270 million years whereas our Rishi calculated this value to be 308.448 million years. It is quite probable that modern astronomers will approach this value during the course of further research. In other words, it can be deduced that size of our galaxy known to Rishi was much larger than the one known to modern astronomers as per the status of their present knowledge.

There are fourteen Manvantar that concern us very much and these Kal Maan comprise yet another super mega level time unit that is to be discussed later. Therefore, it is relevant to learn more about these 14 Manvantar at this stage so that continuity is maintained.

Let it be repeated once again that the appellation of Manvantar under any circumstances does not indicate any connotation to the origin of the Cosmos but it merely points towards origin of the Earth and thereafter presence of life on it. Out of 14 Manvantar recorded, the names of first seven Manvantar are based on famous personalities that remarkably influenced events in that very particular Manvantar which bears his name. Thus, Manusmriti is very explicit on this subject.

Svayambhuvasyasya maanoh shadvanshyah maanvoapraya Shrishtavantah prajah swaha mahitmaano mahoujasah[47]

In the following shlok from Manusmriti once again, mention is made that seven Manu looked after and protected humanity and

other life during their rule in respective Manvantar and brought prosperity in the society.

Svayambhuvadyah saptaitay maanvo bhooritejasah
Svay svayantray sarvaidamutpadyapushchracharam[48]

The names of 14 Manvantar and their beginning dates are given in Table 31.

Table 31: Manu Kal and Respective Beginning Dates

Sr.No.	Name of Manvantar	Beginning Date of Manvantar
1	Svyambhuv	Dvadashi (12 lunar day) of Shukla Paksha (Bright fortnight) of Kartik Mas or 8th lunar month
2	Svarochish	Navami (9th lunar day) of Shukla Paksha of Ashwin Mas or 7th lunar month
3	Uttamaj	Triteeya (3rd lunar day) of Shukla Paksha of Chaitra Mas or 1st lunar month
4	Tamas	Triteeya of Shukla Paksha of Bhadrapad Mas Or 6th lunar month
5	Raivat	Ekadashi (11th lunar day) of Shukla Paksha of Poush Mas or 10th lunar month
6	Chakshush	Dashami (10th lunar day) of Shukla Paksha of Ashadh Mas or 4th lunar month
7	**Vaivasvat**	Saptami (7th lunar day) of Shukla Paksha of Magha Mas or 11th lunar month
8.	Savarni	Ashtami (8th lunar day) of Shukla Paksha of Bhadrapad Mas or 6th lunar month
9.	Dakshasavarni	Amavasya or new moon day of Shravan Mas or 5th lunar month
10	Brahmasvarni	Poornima or full moon day of Phalgun Mas or 12th lunar month
11	Dharmasvarni	Poornima or full moon day of Ashadh or 4th lunar month
12	Rudrasavarni	Poornima of Kartik Mas or 8th lunar month
13	Rouchya or Devsavarni	Poornima of Chaitra or 1st month
14	Bhoutyaka or Indrasavarni	Poornima of Jyeshtha Mas or 3rd lunar month

Vaivasvat Manvantar

At this stage, it will be pertinent to mention that we are experiencing 7th Manvantar known as Vaivasvat after the expiry of six Manvantar pertaining to present sequence of yet another super mega Time Unit, known as Shvet Varah Kalp (to be described in the subsequent pages). Vaivasvat Manvantar started on Saptami (7th lunar day), Shukla Paksha (bright fortnight) of Magh Mas or 11th lunar month. The author has undertaken calculations to ascertain the time of beginning of this Manvantar. It is striking to record that Vaivasvat Manvantar was found to have started 119.312 million or 119.312 x 10 6 or 11 crore, 93 lakh and 12 thousand years ago

Vidya Chand Thakur[49] has edited recent research work in this field that emerged as a consequence of a seminar. It was revealed that Vaivasvat Manu was able to survive Jalplavan or massive destruction which was caused by marine transgression that began at the end of 6th Manvantar known as Chakshush and lasted for a period equivalent to one Satiyug Maan or 1.728 million or 17 lakh 28 thousand years. At the end of Jalplavan, his vessel landed on the shore of a landmass that constitutes present day Kullu – Manali area of Himachal Pradesh, India.

E. Kalp Maan or Measure

Kalp Maan or Measure is the super mega time unit employed in Indian Time Reckoning or Kal Ganana. Three distinct approaches have been adopted by our Rishi in calculating the value of a Kalp - a super mega time unit. The first causative factor is yet another astronomical phenomenon that is hardly known elsewhere. The revolution of Parmeshthi Mandal or our galactic centre around Svyambhuv Mandal or super galactic centre is that phenomenon which gives rise to a Kalp. It takes 4320 million or 4320 x 10^6 or 432 crore years for Parmeshthi Mandal or Milky Way or our galaxy to complete one revolution around super galactic centre or Svyambhuv Mandal. Is it not a mind boggling figure? Moreover, the second approach pertains to a relationship that also accounts for Time Measure or Kal

Maan of a Kalp. Notwithstanding, this domain is equivalent to 1000 Mahayug. Thus in other words, 1000 Mahayug also comprise one Kalp. Third and final approach for deduction of Kalp Maan is yet another relationship which can be calculated as demonstrated in the following illustration:-

Kalp = 14 Manvantar + Sandhi Kal or Time Measure of Satiyug
= 14 x 308.448 million years + Satiyug Time Measure
= 4318.272 million years + 1.728 million years
= 4320 million or 4320 x 10^6 or 4320e6 years

Our Rishi adequately designed suitable terms for addressing various Kalp. The name of present Kalp is Shvet Varah Kalp.

It implies that Satiyug Kal Maan or time measure, as enumerated above, is primarily a period of a major catastrophe termed as Pralay that takes place between two Kalp. The following richa or verse from Atharav Ved amply discloses this information as hereunder:

Shatam tayautam hainan dway yugy trini chatvari krinumah Indragni vishvay devstayanumaanyantamhriniyamanh[50]

In the above richa, there is a mention of writing 4, 3 and 2 prior to 100 Ayuta. The value of one Ayuta is ten thousand. Therefore, 100 Ayuta will amount to ten million. Thereafter, on the principle of *ankanam vamato gatih* inscribing 4, 3 and 2 will account for one Kalp or 4320 million years. This also represents revolution of *vishva devo* or galactic centre around Svyambhuv Mandal or Super galactic centre.

Life of Brahma

Rishi concluded that a Kalp Maan or Measure which is super mega level time unit of Kal Ganana accounts for one day in the life of Brahma. Therefore, one second in the life of Brahma will be 4320 million years divided by 12 x 60 x 60 = 1,00, 000 years. Consequently, one Mahayug will account for 43.2

seconds in Brahma's life. Hence, a day in the life of Brahma works out to be 4320 million years. Similar value will represent a night in Brahma's life. Therefore, one ahoratra or 24 hours in Brahma's life will represent 4320 + 4320 = 8640 million years. One Brahma month will, thus, account for 2, 59, 200 million years (8640 x 30). On multiplication of ahoratra or day and night of Brahma's life with 360 (8640 x 360) will yield 31, 10, 400 million or 31, 10,40,00,00,000 years which happens to be one year of Brahma's life. The life of Brahma is 100 years that is calculated as 311.04 trillion or 31, 10, 40, 00, 00, 00, 000 or 311.04×10^{12} or 311.04e12 years. The duration of first 50 years of Brahma's life is termed as first Parardh and latter half of His life is called second Parardh. This astronomical figure also works out to be life of the Cosmos. In other words, the stock of fuel required to sustain the existence of the Cosmos remains sufficient to last it for 311.04 trillion years or 100 years of Brahma's life. Thereafter, there is a complete destruction of the Cosmos and Brahma itself along with any form of biological life.

Nomenclature of various Kalp and their Beginning Dates

The creation of Srishti or Cosmos does not take place during Brahma's night. Therefore, only the names of 30 days or Kalp of Brahma's month as described in famous epic Mahabharat are given in the following sequence:

1.	Shvet Varah	2.	Neelalohit	3.	Vamadev
4.	Gathantar	5.	Raurav	6.	Pran
7.	Brihitakalp	8.	Kandarp	9.	Satya
10.	Ishan	11.	Dhyan	12.	Sarasvat
13.	Udan	14.	Garud	**15.**	Kourm
16	Narsingh	17.	Samadhi	18.	Agnaya
19.	Vishnuaja	20.	Sour	21.	Somakalp
22.	Bhavan	23.	Saptamali	24.	Vaikunth
25.	Archish	26.	Valmikalp	27.	Vairaj
28.	Gourikalp	29.	Maheshwar	**30.**	Pitrikalp

The 15th Kalp or day of Brahma's life namely Kouram has been designated as Poornima or full moon day whereas 30th Kalp or

day or Pitrikalp has been assigned to Amavasya or new moon day.

In Varah Puran, it is mentioned that beginning dates of the above first seven Kalp are known from memory that is given in Table 32.

Table 32: Beginning Dates of Some Kalp

Sr.No.	Kalp Name	Beginning Date
1	Shvet Varah	Triteeya or 3rd lunar day of Shukla Paksha or bright fortnight of Magh Mas or 11th lunar month
2.	Neelalohit	Triteeya of Krishna Paksha or dark half of Phalgun Mas or 12th lunar month.
3	Vamadev	Panchami or 5th lunar day of Shukla Paksha of Chaitra Mas or 1st lunar month.
4.	Gathantar	Panchami of Krishna Paksha of Chaitra Mas
5	Raurav	Triyodashi or 13th lunar day of Shukla Paksha of Magh Mas
6	Pran	Saptami or 7th lunar day of Shukla Paksha of Kartik Mas or 8th lunar month
7	Brihitakalp	Navami or 9th lunar day of Shukla Paksha of Margsheersh Mas or 9th lunar month

Bhaskracharya, Bahamgupta etc. computed that first Parardha or 50 years in Brahma's life have been completed. At present, first day of second Parardh or 51st year in Brahma's life is in progress.

It is clearly expressed in Vishnu Puran that Naimittika Pralay or wide spread catastrophe occurs after a lapse of 4320 million years which represents a Kalp Maan or measure. As a consequence of this wide spread catastrophe encompassing mega time units equivalent to 2 Satiyug or 1.728 + 1.728 = 3.456 million or 34,56,000 years that are Sandhi Kal or Twilight periods, the Earth no longer will be capable of preserving the atmosphere that is conducive to sustain

biological life on it. Consequently, extremely high dose of incoming radiation emanating from the Sun will completely destroy any traces of water on the Earth, rendering it a deserted planet like the Moon, the Mercury or the Venus etc. Thereafter, life of our planet will shift to Brihaspati or Jupiter which will by that time acquire atmosphere in which biological life could be sustained.

Time Elapsed Since Creation

There are two aspects of Bhartiya Kal Ganana or Indian Time Reckoning. The first aspect deals with beginning of origin of the Cosmos that in turn is related to the life of Brahma. In this connection, it has previously been mentioned that first Parardh or 50 years of life Brahma has already been completed. In other words, it can be stated that 155.52 trillion or 155.52e12 years have elapsed when the Cosmos was created that incidentally is the Kal Maan or time measure of first Parardha. Therefore, Srishtiabd or beginning of origin of Cosmos or Srishti is worked out to be 15, 55, 21, 97, 29, 49, 108 or $155.521972949108 \times 10^{12}$ or trillion years (till 2006 A.D.).

a.	Six Manvantar completed or 6x308.448 million years	=	1850.688 million years
b.	One Sandhi Kal or Twilight before beginning of 7th or Vaivasvat Manvantar	=	1.728 million years
c.	Completion of 27 Mahayug of Vaivasvat Manvantar or 27 x 4.32 million years	=	116.64 million years
d.	Elapsed Satiyug, Treta and Dvaper Yug of 28th Mahayug of Vaivasvat Manvantar 1.728 + 1.296 + 0.432 m.y. respectively	=	3.888 million years
	Total	=	1972.944 million years
e.	or	=	1,97,29,44,000 years
f.	Period of Kaliyug till 2006 A.D.	=	5 108 years
g.	**Grand Total**	=	1,97,29,49,108 years

The second aspect deals with the beginning of the creation and presence of humanity on the Earth. This value works out to be the Kal Maan or Time Measure of Shvet Varah Kalp which is the first day of second Parardh of 51st year of Brahma's life. The calculation for the beginning of Shvet Varah Kalp is given above. Therefore, present Kalp started 1, 97, 29, 49, 108 or 197 crore, 29 lakh, 49 thousand, 1 hundred and 8 or 1972.949108 million years ago from today i.e. 2006 A.D. This computation is known as Kalpabd because the Earth came into existence in the beginning of Shvet Varah Kalp. Nonetheless, Brahma took 17.064 million or 1, 70, 64, 000 years to create life in this Kalp as enunciated by Rishi of Surya Siddhant. Therefore, life on this planet has been in existence for the last 1, 95, 58, 85, 108 or 195 crore, 58 lakh, 85 thousand 1 hundred and 8 or 1955.885108 million years (till 2006 A.D.). Therefore, it is interesting to record the dates of beginning of Time Reckoning or Kal Ganana engulfs both the aspects of Kal.

Jha (1985) has quoted shlok from Brahma Puran in Kalamadhav to elucidate the above mentioned event that is reproduced below:

Chaitra masi jagad brahma sasarjaprathmeahani
Shuklapakshe samgra tattatda suryoudya sati
Pravartyamas tada kalsya gananamapi
Grahanvaranritoon masn vatsran vatsradhipan[51]

Brahma created Srishti or the Cosmos (that include the Earth also) at the time of sunrise on Pratipada or 1st lunar day of Shukla Paksha or bright fortnight of Chaitra Mas or 1st lunar month.

F. Sankalp Path

The reminiscence of these time units was regularly done through a tradition of Sankalp Path that were recited every day before the commencement of Yajna and on the occasion of various ceremonies or activities connected with the life of an individual person. This Sankalp Path comprises two elements

namely above mentioned time units and geographical connotations. The Sankalp tradition is uniformly handled over the entire country. It is quite obvious that geographical reference has to differ due to various locations.

Adya brahmino dveetiya parardhe shwetavarahakalpe saptame vaivasvatmanvantrey ashtavinshatitme Kaliyuge Kaliprathamcharne 5108 gatabde

This Sankalp Path represents two fold reckoning. In the first part, calculations of time elapsed from the creation of the Cosmos till today is referred. As mentioned earlier, Shvet Varah Kalp is in progress at present. It implies that 50 years in Brahma's life have elapsed which amounts to 155.52 trillion or 155.52×10^{12} years. It further indicates that this period has passed since the creation of Svyambhuv Mandal or Super galaxy, Parmeshthi Mandal or Milky Way or our galaxy, Surya Mandal or solar system, Prithivi Mandal or planets and Chandra Mandal or satellite. In the second part of Sankalp Path, creation of life on the Earth is addressed. Life sprang up on the Earth around 1970 million or 197 crore years ago when Shvet Varah Kalp came into existence. Six Manvantar of Shvet Varah Kalp viz. Svyambhuv, Svarochish, Uttamaj, Tamas, Raivat and Chakshush, have already expired.

At present, Vaivasvat Manvantar is in progress in which 27 out of 71 Mahayug have been completed and 28th Mahayug is in progress. In this Mahayug, its Satiyug, Treta and Dvaper segments have also completed their respective duration of Kal Maan or time measure which works out to be 1.728 + 1.296 + 0.864 = 3.888 million or 38,88,000 years. Finally, the component of Kaliyug pertaining to 28th Mahayug started at 02 hours, 27 minutes and 30 seconds on 20th February 3102 B.C. Therefore, it is the 52nd century that is in progress these days. Moreover, 85th cycle of Shasht Varshya or Sexagenary Yug of the present Kaliyug ended in 1998 A.D. It is the 86th cycle of this Yug that commenced thereafter and during 2006 A.D., 7th year is in progress today which is known as Vikari Varsh or year.

7.

SHVET VARAH KALP - A PRELIMINARY GEOLOGICAL RE-INTERPRETATION

Shvet Varah Kalp - the term has been coined by our Rishi to designate first day of 51st year in the life of Brahma. The Kalp started 1972.949108 million or 197 crore, 29 lakh, 49 thousand, 1 hundred and 8 years ago (till 2006 A.D.) on Triteeya or 3rd lunar day of Shukla Paksh or bright fortnight of Magh Mas or 11th lunar month. The total duration of this Kalp would be for 4320 million or 432 crore years. In other words, fourteen Manvantar will cover the entire time span of 4320 million years of Shvet Varah Kalp. Consequently, six Manvantar namely Svyambhuv, Svarochish, Uttamaj, Tamas, Raivat and Chakshush have already elapsed prior to the commencement of present or 7th Manvantar called Vaivasvat. Moreover, it clearly signifies that 1850.688 million years encompassing these previous six Manvantar had elapsed before Vaivasvat Manu came into existence. Accordingly, Vaivasvat Manvantar started 119.312 million or 11 crore, 93 lakh and 12 thousand years ago (or during Aptian age of Lower Cretaceous epoch) on Saptami or 7th lunar day of Shukla Paksh or bright fortnight of Magh Mas or 11th lunar month.

Stratigraphy in Geology deals with a chronological sequence of rocks, events and life on the Earth and Geological Time Scale provides for a systematic connotation to them. Various scientific techniques are employed to date various rocks and

events. Bharat or India has a rare distinction of possessing an array of wide variety of rocks of different era. Moreover, one of the oldest rocks known to mankind and the youngest ones are also found in our country. Therefore, our country is a natural store house in which all kinds of geological information is available which, indeed, is a rare situation.

An attempt is being made in this chapter to weld the perception of super mega time event as propagated by Rishi with modern parlance of geological sciences. Therefore, it is an exercise to evolve a very preliminary model in order to correlate the concept of Shvet Varah Kalp that has been scientifically developed by Rishi and explained in the previous chapter vis – a - vis geological time scale that has been evolved by earth scientists for studying various types of rocks, re-construction of various palaeo - events and palaeo - geography etc. It may be added at this stage that modern geological knowledge like all other sciences, is in the process of further development. No claim whatsoever can ever be made that it has already reached pinnacle of its scientific knowledge since every day latest data are being made available as consequence of systematic research being carried out by different organizations, universities, research laboratories etc. all over the world. Therefore, a lot of additions, alterations and subtractions are a continuum process in the repertoire of geological knowledge. In other words, it can not be emphatically said that data available at present will not undergo further modifications in light of future research in the earth sciences.

Rishi, on the other hand, pursued the knowledge of Kala Ganana or Time Reckoning not only for spiritual growth but also to record Itihas or chronological events of the Cosmos as well as our Prithivi or the Earth.

As mentioned earlier, Shvet Varah Kalp started nearly 1970 million or 197 crore years ago, it does roughly correspond to the information available in study of the oldest rocks available on the Earth.

Table 33 incorporates the philosophy of the conceptual model developed in order to integrate the available information.

In Indian stratigraphy, rocks of Archaean Eon have been treated as the oldest rocks and placed beneath Proterozoic sequence. The oldest sequence of Eoarchaean era of Lower Archaean has been dated to be 3600 million years old. Archaeans are characterized by Charnockite Group of Southern and Eastern India and Khondolite Group of South India and Orissa, Peninsular Gneiss (Older Phase); Migmatite Complex of South India and many other highly metamorphosed sediments. These rocks do not contain any evidence of life, a fact which was also well known to Vedic Rishi.

A. Svyambhuv Manvantar

Svyambhuv Manvantar had started on Dvadashi Tithi or 12th lunar day of Shukla Paksh or bright fortnight of Kartik Mas or 8th lunar month. It is the first Manvantar of the Kalp under study which extended from 1970 to 1661.552 million years. On the other hand, in stratigraphy, Proterozoic Eon has been divided into three parts. Palaeo – Proterozoic era that extended from Siderian (2500 million years) to Statherian (1600 million years) periods; Meso – Proterozoic era that covered period from Calymmian (1600 million years) to Stenian 1000 million years and Neo – Proterozoic era from Tonian (1000 million years) to Neo – Proterozoic III (540 million years) periods.

Nevertheless, Vedic Rishi knew that no life had ever existed on our planet up to 1970 millions ago. Therefore, this Manvantar had started sometimes during Lower Orosirian period of Palaeo – Proterozoic era only. It contains rocks of Aravalli Super Group of Western India; Ranthambhor, Rialo, Sausar, Mahakoshal, Simlipal and Simlipal lava; Dhanjori, Singhbhum, Gangpur Groups; unclassified metamorphics of Bilaspur – Raigarh – Ambikapur, Sukinda Ultramafics of Orissa, Dongargarh and Malanjkhand granites,Closepet granites, etc.

Table 33: Conceptual Model of Shvet Varah Kalp in Geological Time Scale

Sr.No.	Manvantar	Age	Geological Time Scale			
			Era	Epoch	Age	Period
7	28th Mahayug in progress 15 Mahayug VAIVASVAT	Recent	CENOZOIC	Holocene Pleistocene Pliocene Miocene Oligocene Eocene Palaeocene	Recent 65 m.y.	
	13 Mahayug	119.312 m.y.	MESOZOIC	Cretaceous	65 m.y.	
6	30 Mahayug	119.312 m.y.				

Sr.No.	Manvantar	Age	Era	Geological Time Scale		
				Epoch	Age	Period
	CHAKSHUSH			Cretaceous Jurassic Triassic	135 m.y. 250 m.y.	
	41 Mahayug	427.76 m.y.	PALAEOZOIC	Permian Carboniferous Devonian	250 m.y.	
5	26 Mahayug RAIVAT	427.76 m.y.		Silurian Ordovician Cambrian	540 m.y.	
	45 Mahayug				540 m.y.	NeoPro.III

Sr.No.	Manvantar	Age	Era	Geological Time Scale		
				Epoch	Age	Period
4	TAMAS	736.208 m.y. – 1044.656 m.y.	PRE CAMBRIAN	NeoProterozoic	1000 m.y.	Tonian
3	UTTAMAJ	1044.656 m.y. – 1353.104 m.y.		Meso-Proterozoic	1000 m.y.	Stenian
2	SVAROCHISH	1353.104 m.y. – 1661.552 m.y.				

Sr.No.	Manvantar	Age	Era	Geological Time Scale		
				Epoch	Age	Period
1	SVYAMBHUV	1661.552 m.y			1600 m.y.	Calymmian
				Palaeo-Proterozoic	1600 m.y.	Statherian
		1970 m.y.			2050 m.y.	Orosirian

B. Svarochish Manvantar

Svarochish Manvantar is the second Manvantar that started on Navami or 9th lunar day of Shukla Paksh of Ashwin Mas or 7th lunar month which extended from 1661 .552 to 1353.104 million years. Calymmian and Lower Ectasian periods of Meso – Proterozoic era roughly corresponds with it. Metamorphics of Chhota Nagpur, Delhi Super Group, Kalhan, Shillong, Bijawar Group, Gabbro and Anorthosite Complexes of South India etc. are important rocks known from this era.

C. Uttamaj Manvantar

Uttamaj Manvantar happens to be third Manvantar that began on Triteeya or 13th lunar day of Shukla Paksh of Chaitra Mas or 1st lunar month that continued from 1353.104 to 1044.656 million years ago. Upper Ectasian and overlying Stenian periods of Meso – Proterozoic era roughly represent this Manvantar. Kaimur and Simri Groups of Vindhyan Super Group, Cuddapah Super Group and Cuddapah trap, Pakhal Group of South India, Munger Group of East India, Sirban, Shali, Rampur, Larji, Deoband, Garhwal, Bhimtal Groups; Mandi Darla Volcanics. Garhwal volcanics, etc. of West India, etc. are the important suites of rocks belong to this era.

D. Tamas Manvantar and 45 Mahayug of Raivat Manvatar (Rv – 45)

Tamas Manvantar is the fourth one that started on Triteeya of Shukla Paksh of Bhadrapad Mas or 6th lunar month and extended from 1044.656 to 736.208 million years. Moreover, Raivat Manvantar began on Ekadashi or 11th lunar day of Shukla Paksh of Poush Mas or 11th lunar month. Its 45 Mahayug encompass 194.4 million years that have been clubbed together with the former Manvantar to bring the time up to 540 million years. It accounts for the entire sequence of overlying rocks of upper portion of Proterozoic Era known as Neo – Proterozoic Era. It incorporates Tonian, Cryogenian and Neoproterozoic - III periods. Important suites of rocks are

Rewa and Bhander Groups of Vindhyan Super Group; Jodhpur, Simla and Jaunsar Groups; Morar-Chakrata, Bijni, Amri, Kulu, Tanawal, Ramsu, undifferentiated Krols, Infrakrols and Blaini formations etc.

A general appraisal of the proposed conceptual model reflects some significant information. A time span of almost 1428.192 million years which is nearly 72.5% of entire duration of time lapsed till date pertaining to Shvet Varah Kalp which is represented by Svyambhuv, Svarochish, Uttamaj, Tamas and 45 Mahayug of Raivat Manvantar. In geological sense, this domain is encompassed by Proterozoic Era. Not much additional information is available on life etc. from this Era as the rocks are in such a state of great deformation that high grade of regional metamorphism has completely obliterated any such signatures from them. On the other hand, ancient Bhartiya or Indian literature as brimmed with accounts of life in above mentioned Manvantar that forces one to describe it but this narration would be beyond the scope of this chapter.

It is imperative that Prithivi or the Earth must have cooled down completely and solidification process also must have completed. As per geological evidences, there was a total absence of both botanical as well as zoological life at this stage. The rocks were formed mostly by igneous process that gave rise to a massive primordial landmass known as Pangea. During the course of further development, these rocks were subjected to deformation due to tectonic processes giving rise to meta basites. There is probability of massive volcanism whereby further lava poured out and gave rise to additional suite of igneous rocks. The compressive and tensional forces operating on the landmass must have created structural disturbances giving rise to mountains and valleys. Consequently, massive rainfalls must have occurred that created large river systems which debouched into huge reservoirs of fresh water that developed into Massive lakes and seas in due course of time. It

will be interesting to add that there might not have been any salinity in the sea water during those days.

The above scenario was appreciated by Vedic Rishi that has been described in the following richa:-

Yah prithivi vyathmanadringhyah parvatanprakupitan aramnatyo antariksham vimme variyo yo dhama stabhnatasa janasa indrah[52]

It states that Indra or ruler of rains stabilized global deformation that was prevalent during Proterozoic Era with excessive liquid precipitation. It pacified very angry mountains that generated clouds and caused very heavy rains. Further, it created atmosphere around the globe that was accompanied by the protective ozone layer.

Consequently, it appears that Vedic Rishi had known the geological conditions prevailing during Proterozoic Era and the status of life thriving over it. Nonetheless, Brahma took 17.064 million or 1, 70, 64, 000 years to create life in this Kalp as per Rishi of Surya Siddhant. Therefore, life on this planet has been in existence for the last 1, 95, 58, 85, 107 or 195 crore, 58 lakh, 85 thousand 1 hundred and 7 or 1955.885107 million years (till 2006 A.D.). During Neo -- Proterozoic epoch, the river action resulted in the erosion of bed rocks over which those started flowing and transported the bed as well as suspended sediment load towards oceans. As a result of various weathering agencies, diagenesis process had started within the ocean where sedimentary rocks like sandstone, shale, limestone etc. were deposited that contained fossils of marine life that had developed therein. At this stage, Pangean landmass must have surrendered to internal forces and broken down into Laurasian and Baltic shields as well as Angara and Gondwana lands. It is implicit that intervening depressions must have given rise to further seas and oceans.

The above era is followed by a sequence of rocks in which there is a profuse growth of biological life recorded from these deposits. A detail conceptual model is evolved for this sequence in which bulk of palaentological research has been carried out. This model relates to famous Palaeozoic and Mesozoic Era that is given in Table 34.

The perusal of above Table reveals that Chakshush Manvantar encompasses a majority of geological sequence in which very detail information is available. Palaeozoic and Mesozoic sequences incorporate a domain from 427.76 to 119.312 million years. It is the Palaeozoic sequence that succeeds underlying a thick sequence of Precambrian rocks that belong to Archaean and Proterozoic suites. In turn, it is overlain by Mesozoic rocks that have seen very extensive growth of biological life including world renowned dinosaurs as well as extensive volcanic activity as recorded in Deccan traps.

A segment comprising 26 Mahayug of Raivat Manvantar and 41 Mahayug of Chakshush Manvantar has been carved out from Manvantar Vigyan or science to delineate very important sequence of rocks that belong to Palaeozoic Era. It encompasses a time frame from 540 to 250 million years covering a time segment of 290 million years. Its basal part has seen a sudden emergence of biological life. This era has been further divided into six segments discussed briefly hereunder and its main data has already been incorporated in Table 34.

Raivat (RA – 46 to 54) Manvantar

The domain from 46 Mahayug of Raivat Manvantar to 54 Mahayug (RA – 46 to 54) encompassing a period from 540 to 500 million years that corresponds to the lowest most period of Palaeozoic era, is known in geological parlance as Cambrian period. This period had witnessed deposition of sediments in stable platform conditions, extensive time frame for phosphatogenesis and carbonate precipitation and localized

Table 34: Conceptual Model of Chakshush, Raivat & Vaivasvat Manvantar

Manvantar	Mahayug	Diff.	Epoch	Age	Era
VAIVASVAT	VA - 15		CENOZOIC	66 m.y.	
	VA - 13		Cretaceous	65 m.y.	M
			Hauterivian of Lr. Cretaceous	Upp.Cret.	E
CK - 30	CK - 71	CK-4			S
	CK - 67		Cretaceous	135 m.y.	O
CHAKSHUSH		CK-15			Z
	CK - 52		Jurassic	203 m.y.	O
		CK-11			I
	CK - 42		Triassic	250 m.y.	C
	CK - 41			250 m.y.	

Manvantar	Mahayug	Diff.	Epoch	Age	Era
CK - 41		CK-11	Permian		P
	CK - 30			295 m.y.	A
		CK-14			L
	CK - 16		Carboniferous	355 m.y.	A
		CK-13			E
	CK - 03		Devonian	410 m.y.	O
		CK-3	Lr.Ludlow of Upp. Silurian	Upp.Silurian	Z
RA - 26		RA-2			O
	RA - 69		Silurian	435 m.y.	I
RAIVAT		RA-15			C
	RA - 54		Ordovician	500 m.y.	
		RA-9			
	RA - 46		Cambrian	540 m.y.	
RA - 45	PRECAMBRIAN				

evaporate environments of deposition. Martoli Group of Kumaon Himalaya; Kunzam La and Parahio formations of Haimanta Group of Kinnaur – Spiti Himalaya; Lolab and Karihul formations of Hapatnar Group of Kashmir Himalaya etc. are important components of Cambrian sequence. Primitive invertebrate marine life flourished during this period.

Raivat (RA – 55 to 69) Manvantar

This segment covered domain from 55 Mahayug to 69 Mahayug of Raivat Manvantar (RA – 55 to 69) that incorporates a time span of 500 to 435 million years and represents a sequence of rocks which is known in stratigraphy as Ordovician system. The rocks have mostly been deposited in fluctuating marine environment. This sequence is characterized by an advance stage of developments of marine forms known as Trilobites and Graptolites. Evidences of availability of botanical life are found for the first time from these rocks. Ralam, Garbyang, and Shiala formations of Sumna Group of Kumaon Himalaya, Thango formation of Sanugba Group of Kinnaur – Spiti Himalaya, Everest limestone etc. are grouped in this period.

Raivat (RA – 70) to Chakshush (CK – 3) Manvantar

In this section, Chakshush Manvantar also knocked at the door. This Manvantar started on Dashami or 10^{th} lunar day of Shukla Paksh or bright fortnight of Ashadh Mas or 4^{th} lunar month. This segment covered a period from 70 Mahayug of Raivat Manvantar (RA –70) to first 3 Mahayug of Chakshush Manvantar (CK – 3) incorporating a span ranging from 435 to 410 million years that represents a sequence of rocks which is known in stratigraphy as Silurian system. Fish makes its presence felt during this period and more evolved species of plant life emerged. Mountain building activity called Caledonian Mountain Building activity started deforming the landmass. Upper Yong, Variegated and Lower Muth formations of Sumna Group in Kumaon Himalaya is the most important sequence from this geological period.

Chakshush Manvantar (CK – 4 to 16)

This segment contains 4th to 16th Mahayug of Chakshush Manvantar (CK –4 to 16) that encompasses a time span from 410 to 355 million years. It corresponds to a geological sequence of rocks called Devonian system that is, in fact, could easily be addressed as fish period. During this time span, many diverse species of fish emerged and were found in widespread and different environmental conditions. Mountain system continues to rise as a consequence of Caledonian mountain building activity. The sequence of Muth and Jambu Odiyar formations of Sumna Group in Kumaon Himalaya, Muth formation of Sanugba Group of Kinnaur – Spiti Himalaya and Muth & Aishmuqam formations of Guggal Dhar Group, undifferentiated rocks of Morgan, Syringithyris and Fenestella formations of Kashmir Himalaya have been grouped under this period.

Chakshush Manvantar (CK – 17 to 30)

This segment contains 17th to 30th Mahayug of Chakshush Manvantar (CK –17 to 30) that encompasses a time span from 355 to 295 million years. It corresponds to a geological sequence of rocks called Carboniferous system. Significant developments took place during this period and marine regression necessitated reduction in sea level. Consequently, more land areas were available for terrestrial landforms to flourish. Signature of Periodic epiorogenic movements has also been observed in the basal part of Carboniferous period. Thick and luxuriant forests developed during this period and marshy conditions were also created due to wet and humid conditions. In this marshy environment, thick coal seams were deposited. Hence, this period is well known for occurrence of very thick coal seams almost all around the world. Syringithyris and Fenestella formations of Liddar Group; un – differentiated Panjal Volcanics with Agglomerate slates and Nishatbag Beds Formation of Kashmir Himalaya; Kali and Nabi formation of Nihal Group of Kumaon Himalaya and Lipak and Po

formations of Kanwar Group etc. are some of the important suites of rocks belong to this period.

Chakshush Manvantar (CK – 31 to 41)

It covers a domain from 31 Mahayug to 41 Mahayug of Chakshush Manvantar (CK – 31 to 41) incorporating a span of 295 to 250 million years that represents a sequence of rocks which is known in stratigraphy as Permian system. This period has registered a profuse growth of new species of life as substantial increase in surface temperature that is accompanied by humid environment was recorded. Sediments of marine and continental facies were deposited in unstable basins. Permian period experienced two distinct phases of marine transgression registered in these rocks. As a corollary to this activity, seas and oceans deepened even further in which carbonates were deposited.

The fragmentation of Gondwana land that comprised present day Antarctica, Australia, Bharat or India, Africa and South America and located during this period in the southern hemisphere; initiated under the impact of a process known in geological literature as plate tectonics. The above mentioned continents/sub – continent constitute a distinct entity called plates. These plates will play a very important role later in geological times. Permian period recorded volcanic activity also. Therefore, predominantly volcanic rocks, shale, siltstone, plant bearing beds, quartzites, conglomerates/diamictites and slates etc. are common. Girthi and Kuling formations in Kumaon Himalaya, Gechang and Gungri formations of Kuling Group along with Phe volcanics in Kinnaur – Spiti Himalaya and Pir Panjal Group & Zewan formation in Kashmir Himalaya are some of important suites of rocks found in this period.

E. Chakshush and Vaivasvat Manvantar

A component of time frame comprising 30 Mahayug of Chakshush Manvantar and 13 Mahayug of Vaivasvat Manvantar has been identified in our conceptual model from

Manvantar Vigyan or science to demarcate yet another suite of very important sequence of rocks that belong to Mesozoic era. It is interesting to notice that end of Chakshush Manvantar witnessed a very sharp rise in sea levels. Moreover, Vaivasvat Manvantar started on Saptami or 7^{th} lunar day of Shukla Paksh or bright fortnight of Magh Mas or 11^{th} lunar month. Sequence of rocks from Mesozoic era overlie Palaeozoics and extended from 250 to 65 million years. It had experienced maximum changes in marine as well as continental biological forms and plant life. During this era, extensive and intensive volcanic activity has been reported. Concomitantly, diversification and development of phenomenal land life namely dinosaurs etc. also took place for which this era has become famous recently world over.

Chakshush Manvantar (CK – 42 to 52)

The domain ranging from 42 to 52 Mahayug of Chakshush Manvantar (CK – 42 to 52) encompassing a period from 250 to 203 million years corresponds to the lowest most period of Mesozoic era known in geological parlance as Triassic period. Most of Gondwana land was still intact during this period and was heavily glacierised whereas northern hemisphere experienced almost arid conditions. Its main lithology is limestone, dolomite, shale, sandstone, dark grey shale, quartzite etc. This domain has experienced a large scale marine transgression, deposition of felspathic sandstone, oolite, ironstone, shales followed by sub –, tidal carbonates. Exuberant marine and terrestrial animal and plant life is witnessed and early stages of mammals are also noticed in this period. Most important suites of rocks include Kamthi formation of Gondwana Super Group of South and Central India, Mahadeva and Dubrajpur formations of East India; Chocolate, Niti, Kalapani, Kuti, and Kioto formations of Rawali Bagar Group in Kumaon Himalaya; Tambakurkur, Nodular limestone, Hanse, Nimaloksa and Kioto formations of Lilang Group in Kinnaur – Spiti Himalaya and Vihi Group of Kashmir Himalaya.

Chakshush Manvantar (CK – 53 to 67)

The domain varying from 53 to 67 Mahayug of Chakshush Manvantar (CK – 53 to 67) that covers a period from 203 to 135 million years and corresponds to middle period of Mesozoic era is known in geological literature as Jurassic period. This period has acquired popularity recently due to the spreading of the knowledge world wide pertaining to the largest creature ever known to man which is called as dinosaur. These mammals that traveled length and breadth of landmass were so massive that even defies the human perception concerning their abnormal size. These dinosaurs were both herbivorous and carnivorous (flesh eating). Birds also came into existence as the famous fossil of archiopterix reveals a species of aves or flying birds that had teeth in their beaks and is the link between reptiles and birds.

Jurassic period also witnessed a sudden spurt of rise in sea level whereby the phase of marine regression that had started during Carboniferous period was brought to an end. In other words, phases of marine transgression were witnessed. Ferruginous oolites were deposited initially that were followed by shelf deposits under reducing environment (an environment that is devoid of oxygen) that terminated in deltaic clastic sedimentation. The most significant scenario of this period is continuation of fragmentation of Gondwana land and Atlantic Ocean also started opening up. On the other hand, occasional basic lava flows have been reported from Western Himalaya, Rajmahal and Sylhet areas. Moreover, Badesar, Baisakhi, Lathi and Mayakar formations of Rajasthan; Jhuram & Jumra formations of Gujarat; Chikiala and Kota formations of South and Central India; Ferruginous oolites and Spiti Shales from Western Himalaya are some of the important suites of rocks that belong to this period.

Chakshush (CK – 68 to 71) and Vaivasvat Manvantar (up to VA – 13)

A span of time from 68 to 71 Mahayug of Chakshush Manvantar and 13 Mahayug of Vaivasvat Manvantar (VA – 13) extended from 135 to 65 million years. It corresponds to upper component of Mesozoic era which is known in geological literature as Cretaceous period. It experienced shifting of continents of Gondwana land under the influence of continental drift caused by plate tectonics. In this process, Bharat or India got detached from the landmass completely and started migrating towards the north from its location in the southern hemisphere. Meanwhile, Indus suture started opening up and there was a commencement of subduction. During the beginning of Vaivasvat Manvantar or sometimes around middle component of Lower Cretaceous, a period of massive glaciation that had existed in northern parts of the country was replaced by a warmer period. Concomitant to conversion of negative balance of all glaciers, extensive discharges in the rivers were experienced. Therefore, Vaivasvat Manu moved towards north due to these environmental conditions.

Moreover, there was a wide spread development of unusually very large vertebrate animals that traversed terrestrial areas and were known as dinosaurs which had acquired peculiar sizes and shapes. Some of them were grass eaters while others hunted for meat and even devoured fellow herbivorous dinosaurs. These were known to roam around areas that are now parts of Gujarat, Madhya Pradesh etc. Plant life also experienced diversification and precursors of present day species started appearing. For instance, oak, walnut, willow, cocoanut etc. were reported from this period.

Extensive volcanic activity has also been experienced during this period and multiple flows of basic lava had covered an area of more than half a million square kilometers and is popularly known as Deccan trap. Calcareous sandstone, shale, siltstone and limestone are the main rock types of Cretaceous period.

Sylhet trap of Meghalaya, Lohit Granodiorite Complex, Alkali Complex of Sung Samchampi, Tiding Serpentinite of North Eastern India, Ladhakh Granitoid Complex, Karakoram Granitoid Complex and its equivalent intrusives of Ladakh area; Khardung volcanics, Dras Volcanics of Ladakh, etc. are some of the important igneous suites of this period. Other important sequences of this period include Tiruchirapalli, Ariyalur and Uttatur - Patti formations of South India, Lameta and Bagh Groups; Bhuj, Fatehgarh and Abu formations, Khasi Group of Meghalya, undifferentiated Giumal and Chikkim formations of Western Himalaya etc.

F. Vaivasvat Manvantar

A domain of time frame comprising 15 Mahayug of Vaivasvat Manvantar has been identified in our conceptual model from Manvantar Vigyan or science to delineate another suite of very important sequence of rocks that belong to Cenozoic era. It extended from 14th Mahayug (VA – 14) to the present Kaliyug of 28th Mahayug of Vaivasvat Manvantar corresponding to time frame extending from 65 million years ago till present day (more specifically till yesterday). The most significant highlight of this era was complete obliteration of dinosaurs from the surface of the Earth. Moreover, diversification in mammalian life took place. The Tethyan Sea, in which almost complete sequence of Palaeozoic and Mesozoic era is developed and preserved, dried out and Himalaya started rising in pulses.

Cenozoic era has been divided into three periods and seven epochs and this conceptual model has been shown in Table 35. The basal period is known as Palaeogene. It encompasses three epochs namely Palaeocene which is followed by Eocene and later by Oligocene. Middle period is known as Neogene that incorporates Miocene and Pliocene epochs. The youngest period is called Quaternary that covers Pleistocene which is followed by Holocene epochs. This conceptual model is given in Table 35.

Table 35: Conceptual Model of 14 to part 28 Mahayug of Vaivasvat Manvantar

Man.	Era	Period	Epoch	Age	Man.Value	Age,m.y.
VAIVASVAT 15 MAHAYUG	CENOZOIC	QUARTERNARY	Recent			Kaliyug
			Holocene		Dvaper Treta Satiyug VA - 28th (3.888 m.y)	
			Pleistocene			1.75
		NEO GENE	Pliocene	Upper Zanclean	VA-27	3.888 5.3
			Miocene		VA - 22	23.5
		PALAEO GENE	Oligocene		VA - 20	33.7
			Eocene		VA - 16	53
			Palaeocene		VA- 14	66

Vaivasvat Manvantar (VA – 14 and 15)

The domain from 14 and 15 Mahayug of Vaivasvat Manvantar (VA – 14 and 15) encompassing a period from 66 to 53 million years that corresponds to the lower most epoch of Cenozoic era known in geological parlance as Palaeocene epoch. No trace of huge mammals like dinosaur is found in the rocks of this epoch. Niniyur formation of South India; Palana, Akli, Marh, formations etc. of Rajasthan; Madh formation of

Gujarat; Mithakari Group of Andemans; Jaintia Group of Meghalaya; Belcha Dhura of Sancha Malla Group of Kumaon Himalaya; Stumpata, Dibling, Chulung La formations of Kinnaur Spiti - Zanskar Himalaya; are some of the important suites of rocks that belong to this epoch.

Vaivasvat Manvantar (VA – 16 to 19)

The time span from 16 to 19 Mahayug of Vaivasvat Manvantar (VA – 16 to 19) encompassing a period from 53 to 33.7 million years that corresponds to the second epoch of Cenozoic era is known in geological literature as Eocene epoch. As a consequence of continuation of continental drift caused by plate tectonics, various fragments of Gondwana land completely detached from one another. In other words, Antarctica, Australia, Bharat or India, Africa and South America that once constituted Gondwana land got separated out from one another. Concomitantly, Hindu Mahasagar or Indian Ocean along with Atlantic Ocean acquired present day configuration. While all other continents suffered lateral drift, Indian plate raced to collide against Asian plate and this collision started in right spirit during Eocene epoch. In this process, Bhartiya or Indian plate completely migrated from the southern hemisphere and crossed the equator and continued its movement into northern hemisphere.

Consequently, the Indus suture commenced closing and massive subduction started taking place. Extensional tectonism gave rise to massive compressional fields that became responsible for the youngest orogenic movements to get further impetus. Therefore, the resultant impact of above process was continuation of regression of Tethyan Sea which acquired advance stage. Moreover, the first major impulse gave rise to major upliftment of Himalaya which is accompanied by acid volcanism. Sea level also started decreasing during this epoch. Stable marine conditions yielded to unstable ones wherein marine to continental facies were deposited.

Diversification of continental mammalian life also got a fillip. Consequently, gibbons, elephants, horses, rhinoceros, pigs, crocodiles, tortoises etc. evolved also during this epoch. Disang Group, Yingkiong and Phophur formations of North East India; Bandah and Jogira formations of Rajasthan; Berwali formation of Gujarat and Kanji Group of Western Himalaya are some of the important suites of rocks belonging to this epoch.

Vaivasvat Manvantar (VA – 20 and 21)

The duration from 20th and 21st Mahayug of Vaivasvat Manvantar (VA –20th and 21st) incorporates a time domain from 33.7 to 23.5 million years. It corresponds to the third epoch of Cenozoic era, known as Oligocene epoch. Massive fall in sea level is reported from this epoch which resulted in wide spread regression of oceans. This process gave rise to additional terrestrial areas that enabled biological life to prosper. It is obvious that present day antecedent drainages like Sindhu or the Indus, Shatudri or the Satluj and the Brahamputra must have come into existence prior to this environment or just before the commencement of the process of reduction in the sea level. Various species of cats, bears, monkeys etc. emerged and got further diversified due to expansion of terrestrial areas in Cenozoic era. Bermoti formation of Gujarat and Andaman flysch of Andaman & Nicobar Islands; Brail Group and Simsang formation of North East India are important suite of rocks that comprise this epoch.

Vaivasvat Manvantar (VA – 22 to 27)

The time span from 22nd to 27th Mahayug of Vaivasvat Manvantar (VA – 22 to 27th) containing a period from 23.7 to 3.888 million years that corresponds to those epochs of Cenozoic era which are known in geological parlance as Miocene and Upper Zanclean age of Pliocene. Present day land forms came into existence and Indian plate completely got welded into Asian plate. There was a further extension of folded mountain systems known as Himalaya which acquired present day grandeur. The continents and oceans also acquired

present day configuration during these epochs. All three rivers namely the Indus, the Satluj and the Brahamputra had started down cutting their valleys into deep gorges as a process of erosion that was further accentuated by rising Himalaya.

In later Pliocene epoch, even Siwaliks came into existence that is located south of Himalaya. Further diversification of plant life took place and species of sharks; penguins etc. were recorded during these epochs. Sandstones, greywackes, clays etc. constitute major lithology. Lower & Upper Murree Groups, Dharmsala Group, Dagshai & Kasauli formations of Western India; Surma, Tipam Groups of North East India; Warkhali. Rajahmundry and Cuddalore formations of South India; Archipelago Group of Andaman & Nicobar Islands; Lower and Middle Siwaliks etc. are some of the important suites of rocks that belong to these epochs.

Satiyug of 28th Mahayug of Vaivasvat Manvantar (3.888 to 2.16 million years)

The time span involving a period of Satiyug of 28th Mahayug of Vaivasvat Manvantar encompasses 3.888 to 2.16 million years. This domain extends from Zinclean to Lower Gelasian ages of Pliocene epoch. Compressional stresses continued to operate and process of rise of Himalaya kept on going ahead according to its programme. A significant change in the environment was recorded and surface temperatures began to reduce and cooling process started. As a result of this change, beginning of glaciation was discerned and its impact was reduction in the availability of water in the river systems. Consequently, a sizeable reduction in the erosion process of antecedent drainage materialized.

However, these rivers had carved their gorges and valleys very deep right across 200 km wide mountain chains of Himalaya. With the onset of glaciation, it is quite likely that Vedic Saraswati also originated from Himalaya and started flowing in south westerly direction and traversed nearly 1000 km and

merged with the Arabian Sea. In Satiyug period, entire river systems were in place draining the entire region. Kankawati formation and Dwarka beds of Western India; Rajanda formation of East India; Tirit/Kakset Granitoid Complex, Tourmaline Granites, Acid Intrusives of Tertiaries are some of rock sequences of this age.

Treta of 28th Mahayug of Vaivasvat Manvantar (2.16 to 0.864 million years)

The time span involves a period of Treta of 28th Mahayug of Vaivasvat Manvantar that encompasses 2.16 to 0.864 million years. This domain extends from Middle Zanclean to Upper Pleistocene ages of Upper Pliocene and Pleistocene epochs.

Extensive as well as intensive glaciation intensified further and covered major portion of the globe. Massive glaciers came into existence which was responsible for maintaining moisture content in the atmosphere. This widespread and massive glaciation is known in geological literature as Pleistocene Ice Age. Most of mammalian species roaming around in northern India hitherto suffered extinction due to adverse climatic conditions of the Ice Age. A classical example pertains to 52 species of elephants that had flourished in zenith. All but 2 species perished through this holocaust. Frozen remains of white coloured hairy elephant called mammoth have recently been discovered in Siberia. DNA tests conducted by researchers of the University of Leipzig in Germany on a 43 thousand years old bone of mammoth elephant reveal that it had various hair colours. Therefore, glacial and fluvio – glacial deposits like various types of moraines, cirques, assorted sediments etc. have contributed to the formation of boulders, eratics, pebbles, gravels silt and clay.

Dvaper and Early Part of Kaliyug of 28th Mahayug of Vaivasvat Manvantar (from 0.864 years till date)

The time span involving a period of Dvaper and first five thousand years of Kaliyug of 28th Mahayug of Vaivasvat

Manvantar commenced from 0.864 million years ago and is continuing till today. This domain extends from Upper Pleistocene to Holocene ages of Upper Quaternary period. Pleistocene Ice Age further strengthened in time and space but started experiencing pulses in term of colder and warmer period that is known as glacial and inter – glacial periods. After expiry of first inter – glacial period, glaciation got a fillip as surface temperature reduced further that strengthened it and continued for some time before the second pulse of inter – glacial period engulfed the region. This cycle of warm and cold phase continued over the entire region where Ice Age prevailed.

Recent scientific research by the author reveals that signatures of five such pulses of warmer inter – glacial and colder glacial periods have been deciphered, upstream of Suki in Bhagirathi valley in Garhwal Himalaya, Uttaranchal, India. It is Gangotri glacier located in Bhagirathi valley that faithfully responded to fluctuations within the Ice Age. It subjected itself to advance whenever colder phase of the Ice Age prevailed and suffered retreat and vacated areas occupied by it, in response to warmer inter – glacial period of the Ice Age. At present we are passing through a phase of inter – glacial period and faithfully poor Gangotri glacier has also been torturing itself with continuous retreat as monitored during recent years.

Hence, a very crude model has been developed to explain integration of various phases of different Manvantar pertaining to Shvet Varah Kalp with the present day knowledge of geological sciences. Admittedly, this model needs very serious refinement efforts which may perhaps be the subject matter of a future research and publication.

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